SUMMARY OF HEARINGS

BEFORE THE

SELECT COMMITTEE ON GOVERNMENT RESEARCH

OF THE

HOUSE OF REPRESENTATIVES

EIGHTY-EIGHTH CONGRESS

FIRST AND SECOND SESSIONS

UNDER THE AUTHORITY OF

H. Res. 504

PART 3

INCLUDES SUMMARY AND INDEX OF HEARINGS HELD NOVEMBER 18, 19, 20, 21, AND 22, 1963; DECEMBER 11 AND 12, 1963; AND JANUARY 22, 1964

Printed for the use of the
Select Committee on Government Research

FEDERAL RESEARCH AND DEVELOPMENT PROGRAMS—Part 3 (Summary and Index)

Approved For Release 2005/03/15 : CIA-RDP66B00403R000100230041-9

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U.S. GOVERNMENT PRINTING OFFICE
26-665 WASHINGTON : 1964

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C., 20402 - Price 60 cents

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LETTER OF TRANSMITTAL

APRIL 17, 1964.

Hon. CARL ELLIOTT,
Chairman, Select Committee on Government Research.

DEAR MR. CHAIRMAN: There is submitted herewith for committee use, "Federal Research and Development Programs, Summary of Hearings Held Before the Select Committee on Government Research, November 1963–January 1964."

This summary was prepared, upon your request and under the direction of the staff, by the Legislative Reference Service of the Library of Congress. Dr. Dorothy Schaffter, senior specialist in American government and public administration, in coordination with Mr. C. Edward Wise, Jr., senior specialist in science and technology (acting as a consultant to the committee), headed a group of Library staff members who collaborated in its preparation. This group included Mrs. Dorothy M. Bates, analyst in American government and public administration, acting as principal assistant to Dr. Schaffter, and four other staff members who analyzed the testimony.

ROBERT L. HOPPER, *Staff Director.*

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FEDERAL RESEARCH AND DEVELOPMENT PROGRAMS

A Summary of Hearings Held Before the Select Committee on Government Research, November 1963–January 1964

Introduction

During the period from November 18, 1963, through January 22, 1964, the Select Committee on Government Research received testimony from 75 persons each of whom either appeared personally before the committee or submitted a written statement. (An alphabetical list of these persons is found on p. 1265 of this report.) The committee has published this information, presenting it in the chronological order in which the witnesses appeared, followed by statements from other persons who submitted them in writing.

The information in the hearings constitutes an extremely valuable source book on the subject of the Federal Government and research, since the participants were authorities, respectively, on the various aspects of the subject, chosen to represent the Government, the universities, private foundations, industry, and professional organizations. As a source book, however, the published hearings have one defect—it is very difficult to trace statements of all or several witnesses concerning any single subject (as, for example, duplication in R. & D., or the effects on the universities of Federal research programs). Recognizing this difficulty, the committee determined that a subject matter analysis of the hearings would make the information more usable by the committee, Members of Congress, and the interested public. The Legislative Reference Service, at the request of the staff and under its direction, has prepared such an analysis.

Examination of the Table of Contents will reveal the results of the analysis in the simplest possible outline form. The 13 major headings, and their subheadings, indicate the subjects which the 75 individual witnesses considered to be those to which the committee should direct its attention during the present year. These subjects are very similar to those named in various statements by the chairman and to the subjects named for future study in the first progress report of the committee, February 17, 1964.

A brief explanation of the form used in presenting the analysis of testimony in the present report: (1) under each subheading (A, B, etc.) are collected statements on that subject by every witness who dealt with it; (2) each such statement has been given a title, and the statements under each subheading are arranged alphabetically by these titles; (3) following each title is the surname of its author, and a complete alphabetical list of these author-witnesses is found at p. 1265 of this report; and (4) following each statement are the page numbers in the printed hearings on which the statement is based or

from which it is quoted verbatim (the smaller type indicates direct quotation).

The analyses included in the present report were prepared on the basis of the texts of (1) the prepared statements presented by witnesses, and (2) the transcripts of testimony taken at each session. This permitted preparation of the analyses before the hearings were published. For this reason the quoted material in the present report may not be identical to the edited version in the printed hearings, although the content is substantially the same.

I. NATIONAL R. & D. POLICIES AND OBJECTIVES; R. & D. PROGRAM PLANNING AND EVALUATION

A. Status of science and technology in the United States
B. National objectives
C. National policy, formation of
D. Resources, problems concerning allocation
E. Areas of R. & D. which should receive Federal support
F. Program planning and evaluation
G. Program planning
H. Program evaluation
I. Criteria for evaluation of R. & D. activities

A. Status of Science and Technology in the United States

The current status of science and technology in the United States (Killian)

There are evidences of growing complacency about our scientific and technological strength. In spite of our steady growth in these areas we are still short of realizing our full creative potential or of putting science fully to work for the national welfare. It appears that we are on the threshold of greater achievement and this is not the time to slow down our scientific effort. In the same way we must not slacken efforts to advance technology, both military and industrial.

The evidences of increased competition from abroad, measured by various indicators, indicate that, if we slacken our effort, the center of gravity of science may again shift, this time away from the United States. We cannot afford to take this risk.

(pp. 750–751)

Effectiveness and efficiency of Government-supported research (Heald)

There is no question that some Government-supported research has paid tremendous dividends. By and large administration of Government research programs has "been good from the important standpoints of fiscal honesty and scientific integrity, considering the great sums involved." There is a high degree of uncertainty in research, but "the imponderables and uncertainties" surrounding it should not deter efforts to understand the process better and to improve the framework in which research is undertaken, including the support by Government.

I have no specific suggestions on the construction of such measures, except to suggest that the job might be facilitated by the existence of a Federal research policy.

A part of the study of efficiency involves the problem of duplication of research efforts among Government agencies, some of which is no doubt unwarranted. Some duplication is "intrinsic, normal, and reasonable." Some waste is also inevitable.

(pp. 382–383, 400)

Evaluation of end results of research (von Braun)

It is difficult to pick out the research areas that will produce new technology, methods, or insights in the future. There is a certain amount of guesswork and gambling involved. If you look at the entire spectrum of research obviously it has produced a very high return on the money—"probably still by all odds the best investment the country could have made."

(pp. 526–527)

Evaluation of state of our national science and technology (Haworth)

In summary, Mr. Chairman, I believe that our national science and technology is in good health, that the funds and other resources supporting them are well spent, and that the coordination of our national effort is good and constantly improving. To maintain and improve the present state, we must take care to continue the support of basic research all along the line, to encourage, foster, and assist the education and training of new, vigorous and able scientists and engineers and to support on a carefully selective basis those developments which contribute significantly to the reaching of our national goals. Despite the complexities and the increasing costs, continuing success is well within our capabilities.

(pp. 17, 31)

Evaluation of the stability of the Nation's R. & D. effort (Waterman)

The Nation's effort in research and development has been a "remarkably consistent one in its distribution of funds and technical manpower for the past decade." In view of the increasing apprehension in recent years over the large increases in the Federal budget for scientific research and development, attention should be called to the facts (1) that the increases "have been quite effectively matched by the increases in contributions from the other sectors of the economy", and (2) "that the Federal Government is not acquiring a monopoly or control over scientific and technological activities any more than it has been exercising for the past decade."

In view of this stability in distribution of effort, it would seem that one should proceed with caution in the formulation of any radical change in the extent of Federal participation. Obviously such could lead to serious dislocations and loss of valuable time and effort in the process. Besides one must never forget that we live in a highly competitive world, and the modern key to successful competition lies in science and technology.

(pp. 810, 818–819)

General impact of present Federal R. & D. programs (Harris)

We may be entering a very complex period of transition due to decreasing research efforts in weapons development and in the space program. "The country could well now be in a period of declining utilization of scientists and engineers."

The Federal Government will determine whether the national level of R. & D. support drops or continues to grow. Possibly measures can be adopted leading to greater utilization of science and engineering by private industry.

* * * The studies of EJC [the Engineers Joint Council] and other groups have led to the identification of continued national objectives that will lead to the greater utilization of science and engineering by private industry. These objectives are certainly not yet fully accepted by the Government.

The national decisions that will determine whether United States will continue to be the leader of the world in R. & D. will ultimately be made by the Appropriations Committee and other committees of the Congress.

(pp. 831, 835–836)

Limitations of the overall R. & D. effort (Waterman)

(a) *Financial limitations*

* * * Insofar as funds alone are concerned, it seems reasonable to me to assume that the country can certainly carry on an undertaking of the present or greater magnitude, provided its objectives are sound and fully endorsed by the Nation.

(b) *Availability of necessary manpower and training facilities*

If the trend in the production of scientists and engineers "which has remained the same for 40 or 50 years" continues, the number of scientists and engineers employed by 1970 will be doubled. "This gives us some assurance that the future situation will be satisfactory."

But, and it is a large "but," we have fallen badly behind in providing the facilities for this training. Badly needed at our educational institutions are teachers, increases for teachers' salaries, laboratories, classrooms, and operational funds. Unless we can come to grips with this situation, and do so promptly, the requisite manpower will not be forthcoming, or what is very bad, the quality of training will deteriorate.

(pp. 811, 820–821)

B. National Objectives

Definition of objectives (Haller)

If the committee concludes that some confusion and unnecessary duplication exist, a significant service could be performed by defining overall goals and objectives for Government-sponsored research and exploratory development. The committee should continually ask itself: What are the legitimate interests and obligations of the Government in underwriting research, and what are the Government's objectives?

Research is most productive when clear and well defined objectives have been established.

When the objectives are clear, individual programs can be viewed as they fit into the total picture.

(pp. 331, 334–335, 336)

Evaluation of R. & D. programs on basis of objectives to be achieved (Hollomon)

R. & D. must be considered in terms of the objectives which it seeks to fill: (1) addition to the total fund of knowledge through basic scientific research; (2) furtherance of specific national objectives (e.g.,

military and space objectives); (3) improvement of services Federal Government renders to the public; (4) support of technical work to develop the Nation's natural resources; and (5) support of some types of technical work that are important to industry and to the improvement of the economy.

One of the yardsticks to be used in fixing objectives is whether we can afford the cost and whether the cost is justified in terms of the benefit.

(pp. 290–291, 295)

Objectives and role of the Federal Government in science and technology (Haworth)

* * * The first should be to assure that the scientific and technological health of our country is first rate; that is, that we have a vigorous and healthy base to our science and technology, upon which the whole social and economic progress of our Nation is dependent.

A second objective is to develop, or have developed, end items—hardware, processes, etc.—that the Federal Government needs directly for its own purposes. These fall mostly, at the present time, in the areas of defense and space.

Thirdly, I believe that the Federal Government should foster and encourage and, as appropriate, assist in practical developments that are in the general public interest, for which the public as distinguished from the Government is the customer. These include public health, agriculture, and developments contributing to our general well-being and economic health in such fields as energy, water, transportation, etc., where, for one reason or another, the private sector cannot or does not carry out the developments by itself.

[Discussing the first point, he said:] The future state of our scientific and technological health rests primarily on two factors: the maintenance and constant augmentation of a fund of scientific knowledge derived through research, especially basic research, plus a vigorous program of education in the sciences, with particular emphasis on higher education, to be sure that we have a constant stream of new vigorous young scientists and engineers to carry out the various programs that are so essential to us. [This was followed by a discussion of the various types of research, particularly basic.]

I do not believe that I need dwell particularly on the other two objectives that I named, on the one hand the development of products for direct use by the Government * * * and on the other hand developments directed primarily at the civilian sector. These are, I believe, well understood and, of course, will be described to you by representatives of the various mission-oriented agencies.

I do wish, however, to make two points. First, the agencies responsible for such developments should have comprehensive programs, not only of applied research in appropriately related fields but also of basic research, both to keep the agency and its laboratories knowledgeable in the front-running fields of science and to provide an attraction for scientists with the ingenious types of minds that are attracted by the opportunity to carry out such work. * * *

Secondly, whereas the results of basic and of much applied research are unpredictable and prudence dictates broad fields of coverage, development is directed at very specific and predictable ends and hence can be carried out on a highly selective basis dictated by the ultimate aims as related to our national goals. Since development is the most costly element in our program, the selections should be made with great care and deliberation.

(pp. 5–8, 17–19)

Purpose of Federal programs (Calkins)

Federal programs "are not so much intended to advance knowledge generally as to make use of knowledge for particular purposes that serve the Government."

Federal policy now recognizes that research is in the national interest. I heartily approve the support of R. & D. by the Federal Government.

(p. 911)

Relation of scientific research to national objectives (Berkner)

The program of scientific research should be viewed in the perspective of national needs and objectives. Why should we spend tax money to support broad programs of scientific research? Is the return worth the cost? What would be the effect of reducing these expenditures?

First, what is our national objective?

One can reply that it is to maintain a free and peaceful society under our constitutional system of free choice—a society that encourages the full diversity inherent among our citizens in the development of individual opportunity, with economic growth sufficient to reduce poverty continually, and to satisfy ever more fully the needs of our people.

There are five points of impact of scientific research on our national situation:

(1) The innovation derived from an ever-growing knowledge of nature. This allows man to increase his effectiveness in the control of his environment, to be in reach of abolishing poverty, and to grow in productivity.

(2) The part scientific research must play in the graduate training of scientists. Creative scientists cannot be trained without practice, and research cannot be conducted without a sufficient body of highly trained scientists.

(3) Impact of scientific research on our national situation influences public attitudes toward new ideas, products, and services. The focus of public interest in scientific research orients the public to acceptance of the new products and services that the new economy can provide, and accustoms them to ideas of change and progress.

(4) Advancement of knowledge lifts civilization in the cultural sense, and provides an ever-higher richness of living.

(5) Relationship of scientific research to defense.

Only when we are at the forefront of science in every sector can we be certain that an enemy cannot immobilize our posture by some surprise discovery.

(pp. 419–420, 423–424)

The role of science in today's national life (Dickey)

* * * this Nation today requires absolutely first-rate scientific resources and activity in every sector of our national life. * * * Our society is now dependent upon the quality of its science for both its survival and its well-being. * * * First-rate scientific resources and activity in a society such as ours must embrace both the private and public sectors of our national life. * * *

(p. 1075)

C. National Policy, Formation of

Adequacy of a national research policy "dictated by a succession of crises" (Aderhold)

Should the national commitment of research be "dictated by a succession of crises, or is it one that should be for all seasons"?

My personal belief is that because research is so closely related to higher education, and because of the rapidly advancing technology with all the complexities that it brings, we should look at our resources and programs for research in terms of orderly and comprehensive development in the future.

(pp. 903, 907–908, 909)

Consensus between the Congress and the scientific and engineering community on several fundamental questions (McConnell)

The presently somewhat vague consensus that R. & D. is necessary and desirable for the national good must be sharpened. There have been unfortunate misunderstandings and confusions arising from the lack of a coherent national policy under which the Congress, agencies, industry, and the universities might move forward toward commonly accepted goals, and these must be cleared up.

The critical issues are:

(1) What is the appropriate total level for R. & D. expenditures in terms of national objectives?
(2) What is a reasonable and/or necessary proportion of this total for basic research, applied research, and development?
(3) Where and under what conditions should these several activities be carried on, e.g., to what extent should in-house basic research be conducted by the Federal departments and agencies, how much of the effort is to be assigned to universities, and how much done in industry?
(4) Where responsibility has been given to many departments and agencies for the same area has there been effective coordination or is effective coordination possible?
(5) Is duplication of effort where it exists justifiable in terms of cost, the need to know and time urgency?

(p. 865)

Determination of proper national responsibility for R. & D. (Hollomon)

Let me emphasize that research and development involves a large variety of technical activities that cannot all be evaluated in the same way nor are there any general rules that can be specified for the whole of this activity. One of the great misunderstandings is the identification of the $17 billion of research and development now going on in America as a single activity that can be thought of, evaluated, and controlled by a single set of decisions.

There is no easy way to determine the proper national responsibility and policy except to insure that adequate processes for decisionmaking are available within the Government and that policy with respect to the relative participation of the private and public sectors is established.

(pp. 294, 299)

National research policy (Heald)

My principal suggestion is for a national research policy.

The Federal Government is a major influence, if not the preeminent influence, in the character and direction of American scientific research. A policy alone will not guarantee that this vast enterprise will be free of confusion and wastefulness. But it is safe to predict that without a policy uncertainties and ambiguities will grow.

The formulation of such a policy must consider the role of Government itself. Government-supported research ranges from highly specific problem-oriented research to general research concerned with the extension of knowledge. * * *

The question a national research policy should confront is the proportion in which Government should support these two functions and those in between. If Government is to be purely a regulatory agency, then its research should be highly specific. If Government tends more and more to be concerned with the welfare of its citizens, then its research functions become broader.

Within the framework of this basic decision, the policy
—may provide a measure for new and existing research efforts;
—may provide means of eliminating unnecessary overlapping and duplication;

—should transcend the view of the Government agencies, for Government research takes place in a network of competing forces, including the political, the commercial, the academic, and the military;
—might fruitfully go beyond rationalization of current and proposed research by providing means of maintaining a total agenda of research as it affects the public welfare, and establishing priorities since resources are limited;
—might elucidate the relation of research to education, along the lines suggested above, to insure that research does not become self-defeating by weakening the educational base on which the Nation's future depends, including its potential for research itself.

(pp. 386–387, 402)

National scientific policy (Furnas)

* * * As a nation, we may let the situation continue to grow, like Topsy, or we might try to plan our future more rigorously. The trouble with rigorous planning is that it often leads to rigor mortis. It is easy to plan things to death.

The Office of Science and Technology is commissioned to establish and enunciate national scientific policy. It is to be hoped that when the statement of national scientific policy is given it will be in the form of guidelines rather than detailed recommendations. When and if such a policy statement is forthcoming, it should serve as a very valuable guide for future congressional action.

(p. 1009)

Need for a philosophy of research (Calkins)

A mature and perceptive philosophy of the Government's role with respect to research, viewed as a national enterprise, should be developed.

* * * Such a philosophy would recognize the vast social importance of a balanced research program designed to advance knowledge in all important fields; it would recognize that research is best promoted in a great number of diverse establishments, for there is no one best type of organization for all branches of research; it would recognize the importance of strengthening these universities and research organizations as a national resource; it would recognize that research is always uncertain, that there are bound to be significant numbers of failures, but that even negative results are often important and useful; and it would recognize that the function of Government is not just to buy research, but to foster research as a national enterprise for the benefits it can yield in giving man knowledge and understanding of himself and his universe, no less than in giving him material benefits. Such a policy and program would be worthy of the great Nation that we are in this era of our leadership in the world. I see no extravagance in such a program; instead I see it as a confident investment for the future of this Nation.

(pp. 914–915)

Unanswered questions in the future national R. & D. program (Furnas)

Universities constitute the most important element in the basic structure of the present and future national research and development program but they are only one element in the total scene. There is a long array of unanswered questions which trouble every thoughtful citizen, as well as Congress. Here are a few.

[The questions were stated under the following headings: Defense, Space, Human Health, Natural Resources, Technical Assistance, Basic Research, and Proliferation of Supporting Agencies.]

(pp. 1008–1009)

D. Resources, Problems Concerning Allocation

Allocation of Federal funds among various fields of science (Berkner)

This problem is related to the problem of duplication and involves two major facets:

(*a*) Allocation of funds for new facilities. Proposals for new facilities are now well evaluated before they are submitted to Congress. Congress has the right to expect that interagency evaluation of major facilities will be available to it when congressional action is sought.

(*b*) Neglect of new areas of scientific activity. The following are some of the difficulties to be overcome in activating new areas of scientific activity:

(1) In new areas of scientific activity there are few protagonists in the beginning, so granting agencies must apply imaginative foresight to insure that promising avenues are not closed before they have been explored.

(2) While granting agencies have well-developed offices to study proposals in recognized areas, there are no special offices to study proposals outside the mainstream of scientific activity, and such proposals may be shuttled from one office to another.

(3) In budgeting for Congress, budgets are established for recognized activities but no money is requested for exploration outside the mainstream.

(4) Agencies fear criticism for support of proposals which cannot be clearly identified with their responsibilities, and initial investigations in a "far out" field are difficult to identify with agency objectives.

Congress should encourage the granting agencies to examine this problem thoroughly and report the measures that will be taken to protect the national interest in developing new areas of science.

There will always be a good deal of discussion about the relative balance of research allocations to the various fields. This is natural and healthy, but in such public discussions scientists themselves must bear a certain minimum responsibility for their statements, particularly for informing themselves rather fully about the full consequences of their proposals.

(pp. 434–435)

Allocation of national R. & D. resources (Harris)

One of the important issues which the committee should consider relates to the allocation of R. & D. resources.

Is our current allocation of research and development funds and manpower reasonably consistent with our stated and implicit national goals and objectives?

There are other critical nonmilitary problems facing the Nation: oceanography, high energy physics, materials, transportation, water resources, water pollution, and the economic growth rate, for example.

(pp. 828–829, 832–833)

The Government's method of allocating resources to support Federal scientific and technological activities (Wiesner)

In the past, most of the Federal R. & D. effort was concerned with security. Ten years ago there was a close relationship between mili-

tary-oriented R. & D. and civilian needs. Major contributions to science and technology resulted from this relationship.

Now, we face a general stabilization of the turbulent scientific-military revolution of the past decade.

> Weapons research and development can no longer pace our progress to the same extent and new and possibly more conscious ways of ensuring long-range scientific and technological advances are now required.

There is also a need to apply our knowledge to problems of shortages, pollution, foreign economic competition, and to adjust imbalances in our economy created by technology itself.

> * * * We have not progressed to the point in this Nation where we can make the same hard-boiled determination to drive hard because we want a better country that we make because we want to defend ourselves. I think this is a basic problem here.

(pp. 259, 283–284)

Need for balance in support of various areas of research (Stever)

This need is for balanced support over the broad spectrum of basic research in science and engineering, as well as its application to technology. The Government has the greatest power, through monetary decisions controlling the field, and consequently the most responsibility for maintaining the balance. R. & D. in some fields of engineering particularly need more support. Support of graduate education in engineering should be expanded. Part of the funds for R. & D. in every technical area should be for the support of undirected research.

(pp. 1068–1069)

E. Areas of R. & D. Which Should Receive Federal Support

Areas of R. & D. appropriate to Federal support (Jones of Esso)

At the present time and in the immediate future, it is desirable that the Federal Government underwrite the cost of the following research areas:

> (1) Research directly connected with the national defense.
> (2) Research designed to establish standards for public health and safety, and to develop the means for insuring public health and safety in those business areas not susceptible to the private enterprise approach.
> (3) Research in areas, such as meteorology and space exploration, which industry would be unable to justify.

Government financial assistance will also be required for major advances in science and technology if it is desired to exploit them more rapidly than is warranted by private efforts—for example, the development of nuclear power.

The recommended division of responsibility may be summed up as follows:

> * * * Much depends upon the social and economic values attributed to exploitation of the scientific development, and these can only be evaluated properly after long study, careful consideration and exploratory research by Government, private industry, and other interested groups. But once the outlines of the probable benefits to society have been established, we believe further development of the new technology should be financed first, by private industry, and only by Government if it can be clearly demonstrated that the placement of research manpower on this development (and withdrawing it from other employment) is in the overall national interest.

(p. 782)

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Kinds of research which should be supported (Berkner)

Any problem of nature about which a scientific question can be phrased and studied in a way that will yield a scientific answer is worthy of pursuit. Although the attempt may lead to failure, unless some tries are made there will be no successes. The qualifications of the investigator must be considered to determine whether he is qualified to develop the proposed problem and to comprehend fully the implications of his results. The more fundamental a problem, the greater the reward to society for a successful solution, although also the greater probability of failure. The fear of failure sometimes prevents the granting agency from supporting some of the really great problems of science. Finally, some measure of duplication is imperative, certainly in graduate education, but more especially in the investigation of difficult scientific problems.

(pp. 424–425, 431–432)

Priorities in scientific research (Weinberg)

In a sense, this is the most basic of all questions facing the Government in its support of research.

The establishment of priorities in science differs from other areas in which choices must be made because the subject matter is often remote, and Congress and the public are less confident of their judgment and less experienced in exercising it.

Constructive debate on scientific priorities, such as is appearing in scientific journals (Science and Nature), will help to clarify the issues of choice. The presentation of the article, "Criteria for Scientific Choice," which appeared in Minerva, winter 1963, contributes to the debate. (See "Criteria for Scientific Choice.")

(This is followed by a very brief statement of the contents of this article.)

Reasonable bases for making choices in priorities exist, but the organizational structures for making the choices are inadequate, and the Nation has not until this year faced up to the fact that choosing is an economic necessity.

(pp. 316, 328–329)

Priorities in the Federal program of R. & D. (Wenk)

A member of the committee asked whether there was any list of priorities established against which the national effort could be measured. The witness replied:

There is no master list.

(p. 253)

Research policy as a basis for establishing priorities for research (Calhoun)

Priorities for research can only be set after a sound research policy is developed by agencies and by Government. Basic research should be supported and encouraged as a matter of national and departmental policy. Beyond this, research for the mission * * * should be evaluated in relation to national need. There is probably no better way than for departments to set priorities in broad fields, in concert with the Bureau of the Budget and Office of Science and Tech-

nology. The scientific experts should then determine the research program itself.

In the Interior Department, priorities of research programs are developed on a bureau by bureau basis, so far as their own programs are concerned * * * there is no, shall we say, manager of research for the Department of Interior. * * * There is no line administration of research above the bureau level that is separate from all other lines of administration.

Within the Bureau of the Budget, the Office of Science and Technology, and the Federal Council of Science and Technology there is sufficient machinery for achieving interdepartmental and interagency coordination. However, the overall priorities for research should be determined by the legislative arm as well as the executive arm.

(pp. 119–120, 124–125)

F. Program Planning and Evaluation

Planning the program and evaluating the results of Government-sponsored research (Flanagan)

The weakest areas in Government-sponsored research are planning the program and evaluating the results. For contract programs, planning is the greatest need. For grant programs, improved evaluation is the greatest need.

Contract programs

* * * In contract programs there is frequently inadequate use of experts outside the agency for planning and selecting problems and for evaluating the outcomes.

In planning a program and in assigning priorities, the staff of the agency is in effect saying, "These are the most urgent problems which fall within our area of responsibility; these are the problems for which research solutions must be devised."

Surely this task deserves the serious attention of our best minds. At least, however, in contract programs, the staff is responsible for performing these functions. * * *

Grant research programs

* * * On the other hand, the typical grant research program has no one responsible for either planning or evaluation. Grant programs now spend most of their administrative funds on evaluating not research, but research proposals.

For effective research administration, a systematic program of evaluating all types of Government-sponsored research is essential.

Knowledge of outstanding successes and failures could influence not only decisions regarding subsequent proposals from the specific research groups involved, but could establish policies and principles regarding the relative effectiveness of various types of research teams, research administration, and research organization.

Both types of Government-sponsored research programs are needed—(1) those which provide planned attack on urgent national problems, and (2) programs which encourage imagination and insights of individual researchers where they are not required to conform to a central plan of research.

(pp. 930–931, 934–935)

G. Program Planning

Identification of goals and problems (Halaby)

Long-term objectives and goals should be set for the operating agencies, and the congressional branch should share in setting and

working toward these goals. More work, including the attention of Congress, should also go into refining problems and programs.

More often than not, we rush into research and development without having defined the problem with sufficient precision to know what we are really researching for, what is the purpose, what is the aim?

And then a program, I think, needs definition, and within a program comes the project.

I have found, to my surprise, that we had several hundreds of projects coming in, and that we had not developed a program into which these projects were component parts. I am not sure we have yet. But I feel it is very important what we have defined a goal, then a program, and then within a program, projects that lead toward the accomplishment of the whole program and the goals.

(pp. 128–129)

Initial cost and schedule estimates in development contracts (Haber)

(If the estimates are confined to) relatively short steps within the established state of the art, time, and cost can be reasonably measured. But when we take a very long step requiring applied research as well as development and production, then the uncertainty of initial cost and schedule estimates must be acknowledged.

Crucial decisions involving national security will have to be made, providing

a majority opportunity to make advantageous use of the Government-industry partnership.

In this connection, we would like to endorse the current trend toward increased participation of industry in defining the technical objectives of new programs. We believe it is important to employ all appropriate forces to refine the definition of programs at the outset, because good program definition can help reduce unnecessary cost and schedule overruns.

(pp. 607–608)

Planning and objectives of development (Getting)

It is in the area of development where there is the need for clarification of objectives, realistic estimating of costs (within the framework of possibility), and proper placing of management responsibilities. It is vastly important to decide what we want and what we need to accomplish and to determine whether we can and at what cost. In the past projects were decided upon without hard knowledge on whether we could succeed, how long it would take, and how much it would cost. Things have been changing, and the Department of Defense has become more hardheaded about taking on new projects or continuing old ones.

(pp. 1012–1013)

H. Program Evaluation

Evaluation of Government research efforts (Jones of HEW)

The effectiveness, efficiency, worthwhileness, and general impact of Government research are to be measured in terms of scientific achievement.

With particular reference to health research, the advances being made today are possible because of basic findings which took place as much as 15 to 20 years ago. Similarly, "the dimensions and di-

versity of this present effort will underlie the even greater achievements of the next 10 to 20 years."

It is the richness and scope of these present efforts and their promise for the future that is the best measure of the effectiveness and meaning of these programs. A special time perspective in measuring scientific achievement is, therefore, a necessity. Not only is there a timelag between fundamental advances in new knowledge and the practical application of such knowledge to health problems, but there is also a timelag between research in process and the possibility of applying the criterion of scientific achievement.

The concept of efficiency means maximum output with minimal expenditure of resources. It is difficult to extend this concept to research activity because of the inherent uncertainty of output in terms of quality, quantity, and value. A more practical criterion is prudence. * * *

(pp. 538–539, 550)

Evaluation of research programs (Bush)

It is impossible to calculate the efficiency of a research program. * * * I would, for effectiveness in basic research, rate universities and research institutes first, commercial laboratories second, Government laboratories third. * * *

When scientific programs are judged by popular acclaim we inevitably have overemphasis on the spectacular. That is just what we have today. The deeply important scientific advances moving today are not easy to understand. If they were they would have been accomplished long ago. * * *

In any broad program of research the key word in regard to any one aspect of the program is relevance. It is a good word to have in mind in examining any research program. * * *

A person engaged in basic research should have an idea of what he hopes to find out, but it makes no sense to ask him how, when or at what cost his work will be done. "If he knew the answers it would not be basic research."

"We need to use care that our American love of gadgetry does not lead us astray" at the expense of neglecting important but less spectacular projects.

(pp. 461–462)

Evaluation of the efficiency of military and space R. & D. (Killian)

Considerations of "optimum efficiency" are most important in the military and space programs which are the largest users of Federal R. & D. money, exerting a major impact on R. & D. budgets and on manpower utilization.

(p. 757)

I. Criteria for Evaluation of R. & D. Activities

Bureau of the Budget criteria for review of proposals for R. & D. programs (Staats)

1. Relationship of the R. & D. program to demonstrated needs.
2. Scientific or technical merit of the program as evidenced by critical evaluation procedures in the agencies.
3. The relative emphasis to be given particular fields of science.
4. Special factors of timing and opportunity for maximum research impact.
5. The current assessment of R. & D. values.
6. Relative urgency, in the context of budgetary limitations on the one hand and a demonstrated national need on the other.

(pp. 563–565)

Categories under which R. & D. programs should be reviewed (Waterman)

(1) Organization of the Federal Government for R. & D.—organization of executive branch and legislative branch.
(2) Expenditures for science and technology by Federal Government.
(3) Examination of programs themselves.
(4) Examination of how programs are actually carried out and managed.

(p. 815)

Criteria for contracts and grants (Heald)

The Government must set some standards in awarding and evaluating research grants and contracts. Better criteria for measuring research "output against input" would be valuable.

The combination of urgent needs and large sums of money may encourage impulsive and arbitrary granting of research contracts, and may lead to dissipation of funds on fragmented and sporadic projects.

(p. 384)

Criteria for distribution of R. & D. (Brown)

(1) How much R. & D. should be distributed—
  (*a*) By geographical area?
  (*b*) To in-house laboratories?
  (*c*) To private industry?
  (*d*) To universities?
  (*e*) To special corporations set up to do Government R. & D.?
(2) What are the proper ground rules for deciding the above?

(pp. 178–179)

Criteria for establishing types of research to be supported by Federal funds (Bailey)

* * * I commend for your consideration the criteria suggested recently by Dr. Alvin M. Weinberg, Director of the Oak Ridge National Laboratory.

Second, and in a sense an extension of the same subject, I suggest you give attention to the criteria and procedures used presently in selection of individual projects for support to determine if these can be improved as great emphasis is given to our long-range goals and objectives.

(p. 876)

Criteria for evaluation of R. & D. programs (Waterman)

An R. & D. program can be reviewed from two standpoints:

(*a*) *Program content:*
(1) What are its objectives and what are their relative priorities?
(2) Will the program, if successful, meet these objectives?
(3) Is the program technically feasible?
(4) Is the estimated cost of the effort justifiable, in dollars, manpower, and facilities?
(*b*) *Management and organization:*
The operating agency should be held strictly responsible for carrying out its mission; for this purpose it should have adequate authority and funds.

Fundamental to this kind of review are the following considerations:
(1) Competence of agency leadership and staff, and its organization;
(2) Selection of objectives toward carrying out its mission;
(3) Selection and use of experienced and competent consultants and advisory committees;
(4) Planning of programs to further objectives;
(5) Efficiency of management and administration.
* * * If an agency has experienced and competent leadership, and if it selects and heeds advisers of the highest qualifications, then in scientific and technical programs, caution should be exercised against attempting to find higher authorities to make findings on the same technical points and plans.

(pp. 810–811, 819–820)

Criteria for evaluation of support for programs other than basic research (Hollomon)

Different and much more pointed questions can be asked about R. & D. activities supported for objectives other than conduct of basic research.

I would suggest that to be sure that we are spending the Federal funds wisely, we must first examine the program objectives which applied research and development are intended to serve. The most significant question: Is the program itself, that R. & D. aims to serve or improve, necessary, desirable, and in the public interest? If so, to what degree should it be supported? Is it a program which should be wholly supported by the Federal Government, or locally by the States, or by the private sector, or by some combination of these? Having made these fundamental decisions, the problem reduces to one of evaluating the contribution of the R. & D. to that program. This contribution must be measured with respect to the costs that will be incurred in prosecuting it, which in turn is determined by the efficient management of the R. & D. as well as the likelihood that science and technology can contribute to the program itself. [This is followed by an example: application of the criteria to R. & D. in improvement of the national transportation system.]

(pp. 291–292, 296)

Criteria for formulation and execution of sound programs and related R. & D. activity (Hollomon)

1. Assuming the objectives are worthy, the single most important criterion is that of the competence and ability of the people that are involved. * * *
2. With respect to programs other than those aimed at broadly increasing understanding, is management constantly considering the benefits with respect to the costs of the technical work? * * *
3. Sound technical management requires continuing program review. * * *
4. When management is fully aware that the program no longer serves the initial purposes, does it have the courage, the willingness to stop the technical activity?

(pp. 293–294, 297–298)

Criteria for judging the merits of scientific work in terms of expenditures (Thomas)

The criteria for judging the merits of scientific work in terms of wise expenditure of funds will be the phase of the committee's inquiry that will produce the greatest amount of controversy because "experts seldom agree with each other."

* * * Not every scientific research project is successful. In fact, success may be a rarity, but the good scientist learns more from his failures than he does from his successes. * * *
If a research project ends in failure it is easy to condemn it after the fact. Actually the only fair judgment is one based on the question of whether it was

well planned and well executed—and possibly the one of whether or not failure could have been predicted.

It is also dangerous to condemn research because of its apparent triviality or lack of apparent usefulness. * * *

There is one remaining point * * * I believe in very earnestly. This is the social impact of science. I do not know how this committee can go about an investigation except to make it a subjective part of the judgment of the committee members themselves. How does one go about evaluating in a quantitative sense the social value—and the consequent economic value—of the space program, for example? * * * Who can weigh the economic value of having the conquest of space a stated objective for our aspiring minds? But what thinking person can deny that we are greater because of it?

(pp. 412–413)

Criteria for scientific choice (Weinberg)

In my article [copy furnished for the record] "Criteria for scientific choice", in Minerva, winter 1963, I argued that the merit of a proposed work in science can be judged by internal criteria (how competently the work is done) and external criteria (how important the proposed work is to the rest of the world—technological merit, scientific merit, and social merit.)

Having set forth the criteria for choice, five different scientific and technical fields were assessed: (1) Molecular biology was rated of highest priority; (2) nuclear energy also rated highly and deserves strong support; (3) high-energy physics; (4) behavioral sciences; and (5) manned-space exploration. The latter three were rated as of lesser priority for reasons stated.

The matter of choice is not so important so long as the level of support remains small. It is only when science really does make serious demands on the resources of our society—when it becomes "big science"—that the question of choice really arises.

(pp. 316, appended article as cited at pp. 321–328, 329)

Criteria used by industrial research in evaluating a specific research project (Jones of Esso)

* * * I do not mean to imply that these specific techniques are applicable without modification to evaluating Governmental research projects, but criteria of this type should be very helpful.

(a) We carefully estimate our research costs for the successful technical completion of the project. In addition we estimate the amount of further improvement research that would be required in the event of commercial application of the new idea. Costs are estimated for developing a suitable market for the new product or process. * * *

(b) We calculate, in as detailed and precise a manner as possible, an economic balance sheet for the commercial exploitation of the research result. * * *

(c) Finally, before a research project is undertaken, we consider whether there are alternate ways of accomplishing the desired result. * * *

(p. 784)

Policy of reviewing R. & D. programs (Waterman)

This common mistake is made I think and here is a chance to improve. If a program is outlined and the agency concerned, whether it is private or public, gets the best people in the country to advise them on that program * * * then there is no use trying to get a second group which is a second rank and mediocre group to pass judgment on it first, on the same points; that is, on the technical points. This is a pure waste of time and there is no point anyway.

It seems to me the reviews that come should add something to the first review. The first review might be a scientific and technical one in the hands of experts. Be sure you get the best experts.

The next review should take in more than just the scientific and technical point of view. Talk about the objectives and whether it is going to meet them.

A third may be whether it is in the national interest, and so on.

(p. 825)

Validity of "cost-effectiveness" as a test of development projects (Kistiakowsky)

Since development projects have as their objectives new, practical, useful things and processes, each can be judged not only by scientifically trained people on the basis of its technical feasibility but also by others on the basis of what the DOD [Department of Defense] calls "cost effectiveness." I * * * would emphasize that the principle of the method is absolutely sound. Since the results of developments are practical, useful things and processes, the benefits to be obtained from a given project and the costs thereof must and can be weighed against benefits accruing and costs involved if another project or projects were undertaken. Or sometimes the soundest decision is to leave earmarked funds unspent if, for instance, available devices are adequate. The costs of development projects being usually very high and the variety of possible new devices very large, it is imperative to be highly selective in the choice of development projects if our national resources are not to be dissipated.

(p. 609)

II. FINANCIAL SUPPORT OF R. & D.

A. Adequacy of present support for R. & D.
B. Distribution of support between basic and applied R. & D.
C. Basic research, adequacy of present level
D. Alternative sources of support
E. Financing, specific problems

A. Adequacy of Present Support for R. & D.

Adequacy of expenditures for R. & D. (Weinberg)

Although we spend $15 billion per year on research and development, we cannot properly argue that this is all our society can afford when at the same time we have 4 million unemployed.

(p. 317)

Adequacy of Federal Government's expenditure for R. & D. (Haworth)

[The witness described these expenditures, remarking that the subject was "very complicated since many variables are involved."]

In the face of the rapid growth in research and development expenditures the question has been asked: "How much can we afford to spend for such purposes"? Sometimes the question takes the form: "What percentage of the GNP [gross national product] is appropriate?" It is sometimes said that research and development accounts for a significant fraction of the so-called controllable part of the Federal budget. I should like to make a few comments on these points.

Development accounts for the major fraction of the expenditures. Thus the R. & D. "package" covers a broad spectrum running from the most abstruse research to many activities that are hardly technical at all.

I personally do not believe that this should be looked at as a package, especially when considering budgets. Rather, I believe that one should look at the individual parts. Essentially all of the development and much of the applied research is directed at specific national goals: defense, space, public health, agriculture, etc. Our first concern, therefore, in these areas should be the relationship of such research and development to these national goals. * * * Research and development for defense should be thought of in the context of defense. Its financial costs should be in competition with other defense expenditures not with, for example, research for public health or basic research in general. Similarly with space, and other national goals.

(p. 12, 20)

The adequacy of the Federal investment of approximately $15 billion in R. & D. (Wiesner)

The questions naturally arise whether this magnitude and percentage are approximate levels for Federal involvement in research and development and

whether these sizable amounts are being wisely spent. There are no simple answers to these questions. * * *

Federal R. & D. is an all-inclusive term which includes a diversity of functions and interests, involving both research and development, and including expenditures on facilities. Relatively little of the total expenditure on R. & D. is devoted to basic research.

Development, and to a major extent, applied research, are pointed toward well-developed objectives.

* * * The total level of support and balance between different alternatives are decided by the American people through their legislative and executive representatives in terms of some assessment of their contributions to achieve national goals. Here it should be possible to set priorities. Development planning is comparatively straightforward and quantifiable and the conduct of programs is subject to normal management principles and control over cost and quality.

Choices in research are often far more complex. * * * it is clear that we must preserve and protect this portion of our technical enterprise as a vital hedge against the unknown. In fact, I believe that we must be prepared to allow an increasing level for this purpose.

(pp. 257, 281–282)

Adequacy of Federal support of research (Brown)

I think that the United States is spending money [on research] with the right principle. The right principle, it seems to me, at the level that we are at now, and I think there is even some room for that principle to be exercised as the level increases. [The principle] is to support all the people who are good at basic research * * * so that maximum use is made of their talents.

That will cease to be the case if research becomes 10 percent, 20 percent, 30 percent of the Federal budget, but it is not. Research and development is, but research is not.

(p. 181)

The adequacy of the overall level of allocation of national resources to R. & D. in both Federal and non-Federal sectors (Wiesner)

From 1961–1963, there has been a leveling off, at around 2.9 percent in terms of gross national product, of the combined public and private R. & D. effort. National choices will reflect the consensus reached about the importance of particular national goals that can be advanced through R. & D. If national security and/or military expenditures lessen, for example, more expenditures can be directed toward R. & D. and/or civilian needs. In the private sector some industries already show clear signs of decay for want of innovative effort about which, as a Nation, we cannot be complacent.

(pp. 258–260, 281–282)

Effects of increased expenditures for research (Vickers)

Present-day expenditures for basic research are not excessive. The amount should be increased and Government policy should encourage a greater preparation of participation by industry.

Also there appears to be no excessive amount of endeavor in the segment of applied research.

The enormous increase in recent years in the quantity of new, useful products becoming available, and in the rate at which they are being generated has been aided (1) by a tighter coupling between the per-

formance of pioneering research and the initiation of manufacturing and sale; (2) by the enormous increase in the amounts expended for R. & D., both by the Government and by industry; and (3) by greatly improved management in both areas. There is still much to be done in the last regard and the "committee will certainly examine these possibilities thoroughly."

(p. 1065)

Increased Federal support for research (Hutchisson)

* * * The Federal Government should support research at a gradually increasing level as our gross national product increases.

Increased Federal support of research will strengthen the part research plays—

(*a*) in enhancing the economy and general standard of living.
(*b*) in strengthening national defense, and
(*c*) in increasing one of our most important national resources, our supply of competent manpower in science and technology.

(pp. 1018–1019)

Portion of the Federal budget to be spent on research (Bachman)

* * * At the present time we spend approximately 15 percent of our national budget for research. Is this a correct percentage or should it be 20 percent or 10 percent or some other figure? And why? If your committee should find it advisable to make some such percentage recommendation to the House in its final report, you should undoubtedly submit with it a *modus operandi* for authorizing the research funds through existing committees and how these funds could be altered year by year as indicated by the necessities of our Nation. With an overriding structure of this sort controlling the total amount of funds, the research activities of one agency could only grow at the expense of the research activities of another agency, except for such increases as would occur from increases in our Federal budget, by growth or by design. This could also be a controlling mechanism covering new research programs. This discussion assumes, of course, that the maximum funds would be appropriated only if there are a sufficient number of valuable programs to be undertaken. In arriving at such decisions of what, why and how much, competent scientific evaluators should be of paramount importance to the members of committees of Congress who, in the long run, must make the decisions.

(p. 778)

Size of R. & D. budget (Getting)

* * * I do not hold to the thesis that all fruitful work in research and development has been accomplished, nor that this country lacks the intellectual capacity for a continued expanding scientific research effort. Certainly the R. & D. budget should not be larger than the Federal agencies can intelligently manage—but this is not, in my opinion, an immediate or serious limitation. In fact, as a minimum, the Federal support of R. & D., in all forms, should go up at least in constant ratio to the gross national product.

We must provide scientists and engineers with challenging opportunities; industry supported by the civilian economy can absorb only a relatively small fraction of our scientific and engineering potential. Today the Federal appropriations are being managed better than ever before.

As long as we recognize the dominant role of scientific progress to our Nation—in defense, in advancing our economy, in furthering public health and welfare—as long as we have a national resolve to lead and not to be led—as long as we can attract scientific leadership to high levels in Government to give

the programs meaningful policy and guidance—so long should we be willing to bear the costs of scientific research and technological development.

(pp. 1014–1015)

Total expenditure for science as compared with expenditures for other purposes (Weinberg)

The question is: Should we spend more on science and less on foreign aid or housing or civil defense? This sort of choice gets confused because we lump science done for its own sake together with science done to achieve a particular purpose such as improving our military posture.

(p. 317)

B. Distribution of Support Between Basic and Applied R. & D.

Balance between Federal expenditures for basic research and for applied R. & D. (Seaborg)

Figures cited showed that in comparison to the ratio of 1 of every 10 R. & D. dollars which the Government as a whole spends for basic research, the Atomic Energy Commission devotes between 3 and 4 of every 10 of its civilian R. & D. dollars (or 2 of its overall R. & D. dollars) to basic research.

I would urge that a trend toward a similar balance between the dollars devoted to basic research and those expended for applied research and development would be a desirable adjustment for Government-sponsored science as a whole.

(pp. 68–69)

Balance of Federal support for basic and applied research (Calkins)

There needs to be balance between basic and applied research in both the physical and social sciences. Most governmental and industrial emphasis is now on applied research and technology, and contributions to basic research come mainly from universities and research institutions. Only about 10 percent of total national R. & D. money is spent for basic research.

(pp. 912–913)

Balancing financial support among the sciences (Calkins)

It should be determined whether some areas of science are getting too much money as compared to others. Balance should be achieved among all of the sciences, not only between the physical and the social sciences.

Policymakers and administrators need better procedures for getting the scientific advice on which to make decisions as to how support should be apportioned to these areas.

(pp. 912–913)

Costs of various types of research (Bush)

In speaking of "scientific" research, "engineering" research is often included.

A man sitting at a desk and thinking is not an expensive proposition. A scientist directing a team and operating an expensive array of apparatus is. The

costs of research go up very rapidly when one gets into hardware. When money comes easily there is a tendency to rush into use of complex equipment too fast and too far. We may be making this mistake.

If the country pours enough money into research, it will inevitably support the trivial and the mediocre. The supply of scientific manpower is not unlimited.

(p. 461)

The different support of three areas of R. & D. (Teller)

The three areas are pure science, applied science, and development. The emphasis and activities in pure science and in development present a fairly good record, but this is not the case in the area of applied science.

* * * We have often fallen down in spending the millions of dollars in applied science in those pilot-plan operations which require cooperation of many experts, but which do not yet involve the really big money that production and the final phases require. [The witness used the evolving science of weather prediction as an illustration.]

(pp. 939–942, 949)

Maintenance of balance between expenditures for development and for research (Hutchisson)

A balance must always be maintained between effort spent upon development and that on research. Unless this is done, the Nation as a whole will not reap the entire advantage of the new knowledge gained. Over the years a ratio of expenditures of about 10 to 1 has proved to be suitable and probably should be maintained. This is particularly important in connection with the sponsorship of research and development for national defense.

(p. 1019)

Means of measuring the adequacy of Federal support of basic research (Killian)

The relatively small support (currently about $500 million annually) furnished by the Government to the universities for basic research, has an importance out of all proportion to its size.

There is no ready yardstick for measuring how much should be appropriated for this purpose. Clearly the Government cannot or should not make unlimited funds available. How can a wise level of expenditures be determined? I suggest the following rough measures:

(*a*) The talent capable of conducting basic research is limited, and under present conditions we should seek to make it possible for this small group to use its talents to the fullest. We should try to do this and no more.

(*b*) Congress should continue to recognize that basic research should be an integral part of the process for educating scientists and engineers. Perhaps the increasing of graduate students in these fields is "the most telling and persuasive reason" for further increasing support of basic research.

(*c*) Additional funds are needed for costlier instrumentation and "big machines." It is true that some existing instruments are inadequately supported and are not therefore producing the results intended. It is also true that the universities' facilities, including buildings, are gravely deficient.

(*d*) We are not at present fully using the available creative talent for high-quality basic research, and additional private and public

funds can be used in the national interest. The rate of growth in expenditures for basic research should not be as great in the next 5 years as it was in the preceding 5 years.

(*e*) Congress should appraise the procedures, the methods, and the quality of management used by Federal agencies which recommend appropriations for basic research. When these appraisals are on the plus side, Congress should "feel reasonably comfortable" about the projects the people selected to receive support.

Congress itself cannot easily select these people and projects but it can expect a good selection procedure.

The Federal budget should contain a more detailed presentation of the R. & D. programs of the various agencies, including differentiation between the several categories of research—basic, et cetera.

(pp. 752–754, 762–763)

Overemphasis on large research undertakings (Kistiakowsky)

Too much emphasis on glamorous large research undertakings endangers funding of the individual scientist who has been the strength of American science. In recent years an increasing fraction of the Federal research budget has been allocated to special large installations and national laboratories. Progress of research in some scientific areas does necessitate construction of ever more elaborate and costly research facilities; and scientific situations exist in which a large team effort is necessary to achieve objectives, but perhaps the balance has swung too far in this direction.

(p. 612)

Possible imbalance between expenditures for basic and for applied research (Haworth)

[In reply to a question from a member of the committee as to the possibility that such imbalance exists, the witness said:]

I don't have that feeling. I have heard that feeling expressed by a few people from industry, for example, but I have heard the opposite feeling expressed perhaps more often.

* * * one must remember that the better the job basic research does, the more easy is the job of applied research.

As more basic research is accomplished it becomes less necessary to single out a single aspect and work hard on it for reasons of a particular application.

(pp. 50–51)

Relationship between amount of expenditure and research results (Bush)

You cannot assure results in research merely by devoting large numbers of men and amounts of money to the effort.

The best way to proceed is to be sure that really inspired scientists have what they need to work with, and then leave them alone.

[In reply to questioning the witness stated:]

I think we are spending too much money period.

Too much money is not going into basic research, but the great bulk of money is going into applied research, engineering research, and hardware, and that is where we may be overdoing it.

(pp. 462, 470)

Size of expenditures for applied R. & D. (Weinberg)

Since applied research takes almost 90 percent of our research and development dollar, it is here that your committee ought to focus most of its inquiry.

Ideally, the committee ought to review the purposes of applied research, establish priorities, and allocate funds for various purposes, as space, military, nuclear energy, public health, etc. Since this "grandiose exercise may be quite impractical if not impossible," the maximum feasible review will be an attempt to determine whether the R. & D. expenditure for a major purpose—military, nuclear energy, public health, etc.—is in correct proportion compared with expenditures for other aspects of the purpose, e.g., whether the amount spent on R. & D. for the military is right compared with the amount spent on transportation for the military, etc. The choices should not be made, for example, between R. & D. for one major purpose, like public health, and R. & D. for another, like the military.

(p. 318)

Suitability of distribution of funds between basic research, applied research, and development (Haworth)

[The witness charts indicated the total expenditures on a national basis were 10 percent for basic research, 22 percent for applied research, and 68 percent for development.]

This breakdown may well be reasonably satisfactory at the moment, but it could change with time.

(pp. 51–52)

Suitability of distribution of funds between basic research, applied research, and development (Seitz)

[In reply to a question from a member of the committee as to the suitability of the presently existing distribution of funds between the three areas, the witness replied:]

I think our pattern as it has been up to this point is quite sound. Essentially all the good proposals for basic research are being supported. * * * we could spend a great deal more than we are doing on developmental programs. * * * but I think the balance so far has been excellent.

(p. 64)

C. Basic Research, Adequacy of Present Level

Adequacy of Federal support of basic research (Bailey)

A broad base of competence and knowledge, derived from basic research, is necessary to support the highly productive development program required for an expanding economy.

Most scientists consider that the less than 10 percent of the total R. & D. budget of the Federal Government which is devoted to basic

research is inadequate. When retrenchment is required, that part of the R. & D. budget which is for basic research seems to be easily sacrificed in favor of work with more immediate apparent application. Basic research projects which appear to be of purely academic interest frequently open up new vistas. Pure research which appears of value only in satisfying scientific curiosity and adding to the general store of scientific knowledge frequently proves to be of great ultimate benefit; as in the case of penicillin, the control of screwworm, et cetera.

(pp. 872–873, 876–877)

Adequacy of national effort in the area of basic research (Haughton and Smelt)

No scientist would agree that there was enough effort in basic research. I think that there is certainly room for as much effort as the country can put into it. But it is a matter of a balance between that and the other claims on the company's resources, and certainly we have to arrive at a balance between basic and applied research which is almost self-balancing in the sense that if there is no outlet for this basic research in the applied area, it tends to slow down.

[The above statement refers to the corporation's attitude as the witness saw it. In answer to a general question about across-the-board efforts in all areas of science in basice research, this answer was offered:]

No, I think there are areas in the research field that are not having enough at this time. I am thinking particularly of some of the areas mentioned * * * some of the areas which approach more closely the humanities, some of the areas which are not defense oriented. I think that you could look hard at these and decide at this time that they were not in balance with the other side.

(p. 111)

Adequacy of support for basic research (DuBridge)

The national budget for basic research in universities is adequate only when "every competent research scholar in our universities is finding adequate support for the significant research program he is able to carry out." This is not true today; all over the country there are able research scholars with worthy projects who are not finding adequate, stable support for their investigations. The funds should be increased, not cut back.

(pp. 306–307, 311)

Adequacy of support of basic research (Teller)

* * * My impression is that the effort we are directing toward pure research is by and large a reasonable effort. * * * that the amount we are spending and even the way in which we are spending it, that these are reasonable. Whatever is reasonable can be and should be criticized for further improvements.

I believe that the scientific revolution has not yet run its course. I believe that applications and possibilities will multiply, and while we probably are spending enough now, what is enough today probably will not be enough in 1970. But with these reservations, I would give a simple answer to your question. My answer is yes.

(p. 942)

Amount of research support (Berkner)

* * * Perhaps the gravest danger in the congressional deliberations may be that those responsible for reaching the answers to current dilemmas will overemphasize the short-term advantages of support for applied and development re-

search (now taking $14 billion of the total) to the hazard and potential reduction of support for basic science and the search for fundamental knowledge (which still receives less than 10 percent of the total). Yet it is the latter on which all of our future technological advances will depend in the long run. * * *

Further multiplication of support for basic research will be required in these directions:

(a) New areas of science not yet funded.

(b) Extension of scientific strength to the half of the Nation now deficient in it.

(c) The enlargement of programs and facilities to radically enlarge our body of graduate and post-doctoral training.

It is not too much to expect that 1 percent of our gross national product—that would be about $5 billion, or some three or four times the present level of support, will be necessary to fire our national boilers for the optimum development of our new resource—innovation out of science.

(pp. 422, 438)

Amount for basic research (Berkner)

The funds for fundamental research, as compared to that for engineering, development, test and evaluation should be carefully weighed. Less than 10 percent, a little over $1 billion, of the research funds now goes for true research, the remainder going to hardware. The basic research, this billion dollars, is the seed from which the enlarged economy must grow. It should not be destroyed but should be multiplied. Cuts in basic research funds will be reflected in losses to the national economy.

(pp. 422–423, 438)

Areas of basic research not now adequately supported (Seaborg)

Although an insufficient amount of our national research effort is going into basic research, without being able to describe this on a percentage basis, it is possible to list some underdeveloped areas: organic chemistry; low energy nuclear physics; the biological sciences and the general applications of research to the study of disease, heredity, life processes and things of that sort; and anthropology, archeology and areas like that, "just to mention a few that sort of come off the top of my head."

(p. 72)

The cost of basic research (Seitz)

These costs include (1) minimum laboratory and other expenses, (2) expensive equipment in certain types of research, and (3) extraordinary costs for space research.

Research in the first of these three categories lies at the heart of a very large part of the progress of science, and is absolutely indispensable for the evolution of both science and technology in the future. Essentially all areas of good science pass through the corresponding phase as they develop. Many fields never move into a more expensive range. * * * For a long time to come, our Nation should be sufficiently wealthy to support all of the good work that can be done in the first of these categories. * * * I think it is safe to say that as long as our Nation aspires to a position somewhere near world leadership in science and technology, we cannot afford not to support all scientific work at the first level of expenditure that our good scientists can propose and carry through. * * *

[In the second and third categories] the high unit cost implies that principles of selection may be necessary.

It will be increasingly difficult to select research programs involving costly equipment. A selective process will be necessary to determine what equipment should be purchased, and priorities established within the framework of the economy. The judgment of working scientists in their respective fields will be necessary for purchasing of equipment because programs sometimes have more "superficial glamour," derived from spectacular hardware, than scientific merit.

(pp. 59–60.)

Federal support of basic research (Kerr)

The case for Federal support of basic research has been made many times, but I feel that it cannot be made too often or too emphatically. There is no real danger of undesirable duplication in basic research, except when work cannot be published for reasons of security. Some duplication is desirable and beneficial.

I agree with many recommendations that the present Federal support—less than 10 percent of the R. & D. budget—should be substantially strengthened. Support for basic research should not be confused with the massive activities in engineering, testing, and development that make up the other 90 percent.

(p. 1020)

Importance of understanding and protecting basic research (Wiesner)

Basic research adds to our reservoir of knowledge about the universe around us, on which all technology rests. * * * we must preserve and protect this portion of our technical enterprise as a vital hedge against the unknown. In fact, I believe we must be prepared to allow an increasing level for this purpose.

Within basic research, priorities must be set largely by the scientists themselves in contrast to priority setting for development.

* * * Although the principal purpose of the almost $1 billion in Federal research funding that flows into universities is justified in terms of the relevance to the sponsoring Federal agencies, this work is nonetheless intertwined with education in a major way. Federal support for university research * * * contributes in an important way to meeting future manpower needs even while providing for vitally needed research.

* * * We make a very bad mistake in lumping this all together and calling it research, because this year, for example, what you would really call research amounts to something under a billion and a half dollars in the $15 billion budget.

(pp. 257–258, 279)

Increased support for basic research (Furnas)

More money should go to basic research, even if this means small reductions in some expensive development programs, because:

(a) Directly and indirectly this is the best way to increase the supply of top scientific and engineering talent.

(b) Good basic research findings, if produced in time and properly needed, can prevent many very costly errors in development projects, particularly in complicated weapon systems and space vehicles.

(p. 1009)

Reduction of funds for basic research (Seitz)

At the present time good basic research tends to be squeezed out in times of budget pressure.

This is really false economy because—

(1) Only a relatively small amount is involved in basic research, and therefore little is gained by reducing it;

(2) Cutting basic research means a loss of basic knowledge needed for development programs and thereby makes the developmental programs more costly [in reply to a question from a member of the committee, examples were cited]; and

(3) A cutback of research in academic institutions leads to a downgrading of graduate and postgraduate education and a consequent decrease in the number of quality of trained research available to the Nation.

The cuts of the budgets of the National Science Foundation and the National Institutes of Health are not justified if we are to maintain our growing scientific strength. They endanger the basic research carried out by independent scientists, many of whom are primarily supported by the above institutions. This will endanger our future stature in the world of science and technology because it strikes at the core of scientific strength.

There is national danger if funds for good basic research do not grow annually at a rate of 15 or 20 percent per year.

The reduction in funds for the National Science Foundation will seriously affect scientific education in about 5 years or sooner.

(pp. 61, 63)

Size of the basic research budget (Weinberg)

The size of the basic research budget must be judged on its own merits—it must stand by itself against foreign aid or defense. The merit of one kind of basic research can only be judged in relation to other basic research.

I can offer no external criteria for determining the overall size of the basic research budget.

I would therefore suggest that we gear the basic research budget to the gross national product. We ought to commit a certain fraction (say 0.5 percent) of our GNP to this purpose. This formula would provide funds for all really competent researchers and would curb the exponential growth of expenditures for basic research. Neither will basic research wither as it would if its budget remained a fixed number of dollars.

(p. 318)

Support of basic research (Long)

The total cost of all Federally supported basic research is by no means large when compared to the job it has to do. The amount is about $1 billion per year. Basic research done with all other funds, public and private, in other facilities costs roughly the same amount. The total is less than one-half of 1 percent of the gross national product.

* * * The basic research accomplished by these funds is the underpinning on which our great technical industries rest. It is essential to the very much larger amounts spent in developmental work. And its plays a major role in the training of our scientists and engineers as well as of scholars in many other fields.

Considering what we get from this support of basic research, I firmly believe that it is a great bargain.

(p. 484)

Value of basic research (DuBridge)

The 3 percent of the total Government budget for research and development which is being used for basic research in the universities is

the most important segment of the total, has been the most fruitful of all expenditures, has been subject to the least waste, and is, above all, the one segment of the R. & D. budget that should be expanded and not contracted.

Federal support of basic research was essential if the United States was to seize scientific leadership of the world after the war.

One criticism of basic research, that Federal support has driven out private and State support of research, is false. Private and State support have also grown rapidly, and in fact Federal support has stimulated a higher level of expenditure from private sources than would otherwise have been possible in the postwar period.

Another criticism of basic research, that it is growing too fast to be healthy, is also false. Growth must be rapid at the present time because science in American universities has been in its childhood and adolescence; as it is older the growth rate will slow down. Part of the rapid growth rate can be attributed to inflation which has affected all prices since 1946. It is essential that budgets would rise and that the period of rapid rise should continue at least for a few more years.

The results of increased expenditures are shown in the assumption by the United States of world leadership in science. The Nation has benefited in many specific ways, and these benefits have been extended to the universities, to the economy, and to our national security.

(pp. 305–306, 308–310)

D. Alternative Sources of Support

Centralized control over research (Calkins)

Centralized research and centralized control over research funds are not desirable. There should be "alternative sources of support" for research.

(p. 914)

Pattern of organizations carrying out R. & D. tasks of the Nation (Furnas)

* * * Over the course of years, a pattern has evolved whereby four classes of organizations are utilized to carry out the research and development tasks of the Nation. This pattern was not arrived at through any grand design or master plan. Rather, it was the result of a pragmatic American approach of trial and error.

The four classes are universities; nonprofit organizations other than universities; industry; and Government in-house laboratories. Each type of organization has some positive and some negative characteristics when measured against the overall requirements of the national research and development needs. My own analysis of these characteristics is as follows:

* * * * * * *

Note that the quadrilateral approach to handling our defense research and development problems has evolved under the motivation of finding the best way of accomplishing a very difficult and extremely important task. Taken all together, the positive and negative characteristics of the four types of organizations balance out to produce an extraordinarily effective pattern of action. Elimination of any one type would be truly deleterious. Hence, improvements to one segment of the operation should not be accomplished by seriously weakening or eliminating one of the others. We greatly need them all.

The very diversity of the four types of organizations carrying on the Nation's research and development represents an inherent virtue which, apparently, is seldom realized. * * * In a free society * * * the allocation of talent is more by individual preference for the opportunities offered than by command. Hence, the greater the variety of choices afforded by [the four types described above], the greater the probability of the Nation acquiring the best talent for solving the national problems.

(pp. 1005–1007)

Possible relaxation of effort by industry and the educational institutions, in the support and conduct of research, as the Government expands its role (Wenk)

The Office of Science and Technology has not as yet devoted a great deal of attention to this problem, although the OST is exceedingly interested in the total national activity in R. & D. There appears to be a

leveling off of the percentage of our gross national product which is being devoted to research and development, both from the Federal Government as a source and from the private sector. We are endeavoring to understand this. It is a phenomenon in which, for example, one cannot establish an arbitrary limit or target of support for research and development.

We do not, for example, as yet see clearly how research and development contribute directly to economic development, although we know in the aggregate that this has happened.

* * * speaking personally, I would say that I have great concern that the contribution by the private sector shrink no more.

(pp. 251–252)

Sources of support for research (Furnas)

Support of the national research program should come not only from the Federal Government, but from States, foundations, industry, and individuals.

(p. 1007)

E. Financing, Specific Problems

Adequacy of present Federal support of R. & D. in Department of Commerce (Hollomon)

[Discussing support of the agencies for which he has responsibility, in reply to questioning from a member of the committee, he said:]

I do not believe, however, that we are spending a sufficient amount of Federal funds or State funds to meet major civilian economic requirements such as urban development, such as transportation and such as support for the basic technology related to industry, particularly to that industry which isn't so sophisticated; i.e., textiles, building and construction, those industries that serve the basic needs of society.

What I am trying to say is that for the support of technical activities of the missions of the bureaus for which I have responsibility, I don't believe these R. & D. activities are out of line. On the other hand, for the activities that aim, for which I do not have responsibility, which aim at what might be called the

basic technology, related to our civilian economy, I do believe these are out of line.

(pp. 303–304)

Amount of research needs of different activities (Denney)

Although no quantitative answer is possible

we hope that the committee will be able to throw some light on the question of detecting the incidence of diminishing returns, trying to find the point where the cost of a research effort ceases to be justified by the result.

Some useful exploration can be accomplished which will shed light on these two points:

(1) What are the relative research needs as among different kinds of activities, e.g., military, health, foreign affairs?

(2) Are there guides to the point where the cost of a research effort ceases to be justified by the result?

(pp. 184, 193)

Continuity of financing of R. & D. (Furnas)

Stop-and-go financing is very harmful to national R. & D. programs. Assurance of continuing support is necessary to effective R. & D. Congress can have substantial influence in remedying the present situation.

(p. 1010)

Determination of R. & D. requirements (Brown)

It is difficult to determine what R. & D. requirements are for the Department of Defense. There are many factors involved which have to be considered: technical inputs, and the inputs of military experience, fiscal situations, and international considerations.

(p. 177)

Difficulty in avoiding wasteful expenditure (Brown)

Sometimes a great deal of money is spent on developing a weapons system that at completion is not deployed. When a development decision is made, it is not known what the future situation will be at the time the development is completed. About half of big developments probably will not become deployed weapon systems. However,

it is desirable probably to err on the side of having them when they are unnecessary rather than not having them when they are necessary.

(p. 177)

Funding of R. & D. (Haller)

Stop-and-go funding is wasteful and distracting in performing R. & D. research for the Government. A stop order breaks the rhythm and continuity of creative thought, people must be reassigned, and if the project is started again the startup costs are expensive and new people may have to be found. Interruptions in funding also frustrate and discourage scientists.

The Government agencies procuring research and development should be able to plan so that the funding and decisions are timely. We hope Congress will take steps to enable the timely commitment of funds.

(pp. 332–333, 335–336, 338)

The justification for "crash" programs of R. & D. (Teller)

When the real need arises, I am not against a crash program. My main criticism is that we do not anticipate the difficulties to a sufficient extent, and that therefore the argument, the apparent needs for crash programs do arise. What we are now doing in space to my mind is not so wrong. What we neglected to do in the early 1950's and the late 1940's, that is where the criticism should rest.

* * * * * * *

* * * I also think that a crash program should be very well justified before it is adopted. [Examples from the space program were cited.]

(pp. 945–946)

Means of achieving economies in R. & D. programs (Waterman)

There are several ways in which one can save large amounts of money. One is to look carefully at a large program before it begins, to be sure that it is feasible to do.

* * * * * * *

A second is to watch out for crash programs. Crash programs have to be started fast. They have to do things quickly, which is a costly way of doing it and they make more mistakes too.

(p. 824)

"Overspending" on research (Heald)

"Overspending" on research can lead to "subsidy of mediocrity" and resulting damage to the quality of research.

Certain fallacies have gained widespread currency.

The fallacies are that all problems are capable of solution, that the solutions lie in knowledge resulting from empirical research, and that the research can be produced by saturation staffing and saturation financing.

The successful forced-draft projects (for example, the Manhattan project) of World War II are largely the cause of these fallacies.

(pp. 383–384, 400–401)

Relationship of funds available for research to research output (Jones of HEW)

To appropriate more money for an agency than it has requested in the expectation of obtaining more research is not always successful. Other factors besides money determine what can be accomplished. Among these are the availability of research projects which conform to the criteria of quality which have been established, and the availability of competent researchers.

NIH is a case in point. Although Congress has appropriated funds in excess of the Department's budget request, all the money has not been spent because of the limiting factors mentioned above.

[Because] the quality of research supported by NIH relatively has continued to go up, * * * the percent of projects proposed that have not been funded because they did not meet the criteria of quality, has remained about the same level through the years, about 48 percent.

* * * * * * *

[with respect to shortage of personnel] as to NIH, its problems are related to a lack of competitive situation with even educational institutions now for the services of competent scientists who are available.

(pp. 553–554)

Stable financing of research (Rose)

Funding of research programs within the confines of the Federal fiscal year funding pattern makes it difficult to carry out research programs in the university. More stable financing is needed.

A great deal of what appears to be unnecessary effort on the part of Government and university officials is required to meet the requirements of the paperwork necessitated by reports and renewal proposals.

(p. 792)

The timing of congressional action on the funding of research programs (McConnell)

The single largest deterrent to the proper conduct of research has been in the timing of the actions of Congress itself with respect to authorizations and appropriations for both ongoing and new programs. To be successful, research programs must be planned and scheduled well in advance. It is unfortunate that the usual university academic year and the Federal fiscal year are badly spaced relative to each other for this purpose; however, when Congress fails to act on appropriation bills prior to the beginning of the normal fiscal year, the establishment or continuation of projects and programs which often begin in the summer are seriously affected and valuable research time is lost.

Personnel on projects which have received formal or informal approval but are not funded must make alternative plans. Between June 1 and July 1 each participant on a project has to make his own final decision based on the likelihood that the Congress will act in time. * * * Delay in appropriations causes research to suffer not only for the summer but for the entire year and possibly for the following year as well, for it takes time to build a good research staff.

Longer term grants and contracts would mitigate this problem to some extent. * * * An additional benefit * * * would be a reduction in time and effort spent by institutions and agencies in handling the proliferating paper work asssociated with annually funded grants and contracts.

(p. 864)

Validity of the rapid increase in public support of R. & D. (Harrar)

Questions as to this validity are being raised by this committee and others.

First, I believe the principle of gradually increasing public support of research and development is sound and the satisfaction of the demands for the well-being of society can be accomplished only with the aid of a vigorous, intelligently planned and continuous program of research aided by both public and private funds. Within our democratic system, it is to be expected that public funds will continue to be the major source of support.

If decisions to press research in space, atomic energy, defense, health, nutrition, and many other disciplines are valid, I do not think that the amounts of money presently being applied to research are out of proportion to need. * * *

In our society, needs of many kinds will continue to exceed available resources so that decisions must be made with respect to the most efficient and productive use of public funds. This I understand to be one of the principal goals of this select committee. I would submit that it is possible to supersaturate both chemical and social solutions. This latter undesirable condition could occur if excessive funds are provided for research without a sufficient body of qualified investigators to insure optimum benefit from the investment. The balance between the size of the research community and the demand for scientific competence is a delicate one even under normal conditions. If new support enters the field in increments beyond the capacity of the scientific community to respond, the quality of performance must necessarily suffer.

(pp. 1016–1017)

III. ORGANIZATION AND ADMINISTRATION OF FEDERAL R. & D. PROGRAMS

A. Favorable evaluations of the present system
B. Suggestions for attaining greater efficiency and economy, and better organization
C. Specific problem areas
D. Fragmentized versus centralized organization of Federal R. & D. functions
E. In-house and external research facilities, choice between use of
F. Grant and contract processes

A. Favorable Evaluations of the Present System

Adequacy of organization for science and technology in the executive branch (Waterman)

Thus the executive branch of the Government has taken what seem to me to be important and logical steps to assist the President in improving the coordination, planning and degree of overall supervision of the Federal contribution to the national effort in science and technology. These steps have been taken only comparatively recently. But I believe them to be soundly conceived and to have adequate promise of dealing efficiently and ably with the major problems in the executive branch that are the present concern of this committee.

(pp. 815, 822)

The efficiency of Government research programs (Murray)

These programs are certainly getting maximum return in contract research, for several reasons: (1) our Government agencies make certain that the best talent available is selected to do the research; and (2) there is intense competition today for Federal research funds and this competitive atmosphere further assures us that the best talent will be available. "Cost comes after competence in research considerations."

(pp. 456–457)

Evaluation of the Federal R. & D. effort (Harris)

Many charges are made of waste and inefficiency in the present R. & D. programs. There have been commitments to programs that have not reached maturity, and "without any doubt some of these criticisms are entirely warranted". No large program of the urgency of the national R. & D. effort could be flawless. If there is to be sufficient boldness in the national program there certainly will be failures in the future.

In general, however, R. & D. has contributed to our overwhelming defense and atomic emergency competence, to a dynamic space program, to our national

agricultural productivity, which is the marvel of the world, and it has contributed to the highest standard of living and individual help in the world.

These accomplishments cannot excuse waste and inefficiency, but they can speak to the general effectiveness of research and development.

(pp. 829–830, 833–834)

Evaluation of the Federal system of support of research (Kistiakowsky)

[The witness briefly described the growth of Federal programs of research.]

Except for Government-operated and the privately-operated but Government-financed large establishments, most of the Federal research funds are spent in nonprofit institutions of higher learning, largely through the medium of research project grants and fixed-price contracts. The agencies which use this system rely on scientifically qualified consultants to rate research proposals of scientists seeking Federal support of their work, and most agencies accept such ratings in allocating their funds, thus avoiding the danger of excessively bureaucratic decisionmaking.

It is my considered judgment that this system of research support has been outstandingly successful. From a definitely secondary status before World War II, American science has now reached a position of world leadership. The proof of this statement is manifold. * * * I attribute the relative rise of American science in the face of this competition [from U.S.S.R., Great Britain, etc.] to the project grant system and to the diversification of research support among several executive agencies. Both factors act in the same direction: the prevention of overcentralization and of too heavy dependence on decisions by men who, because of their administrative activities, are not able to maintain their scientific competence. * * * I believe that both the U.S.S.R. and Great Britain suffer from overcentralization of research support. * * *

(pp. 610–611)

Executive branch organization of R. & D. functions (Staats)

At the present time Federal R. & D. is undertaken in response to the program responsibilities of the department and agencies, and it is conducted in the agency responsible for administration of the particular program.

* * * These are the facts of life, and while these arrangements at times may raise the spectre of unnecessary overlapping and duplication, we do not believe that these criticisms are generally valid. To attempt to produce a neat organization chart by simply consolidating research and development in one or a few agencies would, in our judgment, obscure the purposes for which research and development is conducted, and make our decisionmaking less rational in the long run. We believe that we should not alter the present basic organization of research and development activities, but instead concentrate on improvements in coordination of planning and communication.

(p. 565)

Government as one element of the national R. & D. effort (Harrar)

* * * any discussion of Government support of research and development should be based on the total spectrum of national requirements regardless of their source of support. Although Government is the greatest single contributor to scientific research, the entire research pattern within our Nation is inescapably interrelated through mutual interests and the many common goals to which these efforts are directed.

In our country there are four great forces which interact to move the frontiers of science forward. These are in descending order of magnitude: Government, business and industry, the sector represented by private philanthropy and voluntary agencies, and the individual donors who in the aggregate contribute mightily to the support of our educational and scientific institutions. This pluralism is, I think, exceedingly healthy and guarantees broad and continuing investigation and competition in the best sense of the word toward increased excellence.

(p. 1015)

The role of the science administrator (Harrar)

* * * Much of the accomplishment of science derives from the continuous individual efforts of career investigators who depend upon others to interpret their roles and support their research. In recent years, due to the burgeoning growth of the national scientific effort, there has of necessity been increasing attention given to the place of the science administrator in the complex pattern of scientific research development. We have been fortunate in the caliber of individuals who have been attracted to this critically important service although we have perhaps not always realized the full significance of their contributions.

I believe that the role of the science administrator must be to apply critical and impersonal judgment to the area or agency for which he has responsibility; that it is incumbent on him to increase the efficiency and broaden the communication within and between agencies and, finally, that it is his responsibility to present cases before appropriate bodies with confidence that the position is sound and consonant with the public interest.

(p. 1016)

Study of successful programs as a contribution to understanding programs which failed (Harris)

This general category deserves attention. There have been several very important success stories (development of the ICBM and the Polaris program, for example). A study of these successes might contribute to an understanding of failures in other cases. The executive branch has faced up to its responsibility for management and coordination of research with increasing effectiveness, and has devised effective methods and procedures.

(pp. 831, 835)

B. Suggestions for Attaining Greater Efficiency and Economy, and Better Organization

Attainment of maximum efficiency and economy in space program (Webb)

[These measures were suggested:]

(1) Consistent support of vigorous, effective and strong administration in this program.

(2) Funding the program at a rapid rate, rather than on a stop-and-go basis or on a crash basis. I think that the cuts made this year in our budget will cost the country between $2 and $3 billion to do the same amount of work.

(3) Now, I think also you cannot spend the money if you think it is not wise to spend it that year.

(p. 85)

Balance between research and operations (Denney)

One question is whether there may be some ideal balance between research and operations. Although research and operations are obviously mingled, where is the point at which it is profitable to break out

a research specialist to take over a reasonable portion of the research job, in order to leave the operator free to concentrate more on his action responsibilities? Division of labor is more efficient if there is enough separable research work, and if the separation from the operator is not so wide as to make the research of no effect. The balance between research and operations will probably vary with different activities.

(pp. 184, 193–194)

Contracting and auditing procedures in Government research programs (Dickey)

Simplification and standardization of procedures would make it possible, more frequently than at present, to use a given set of documents in relations with a number of awarding agencies.

Each institution might be assigned a single cognizant governmental audit agency which would handle governmental procedures for all Government-sponsored research at the institution. This would not impair the usefulness of existing multiagency awards procedures.

(p. 1077)

The degree of association between research and operational programs in a department. (Calhoun)

[This problem has two sides:] (1) Some mission programs have no support at all for a better elucidation of the science underlying their operations and the factors that control them. * * *. (2) A parallel to the use of research is the need for the problems and experience of operations to work their way to the attention of the research laboratory.

Several questions may be raised in connection with this situation:

(1) How well are research results woven into operational decisions?

(2) Research results are not automatically used. Is this a matter of timing or of substance? There is need for continuing attention to procedures that will insure use of research results.

(3) Is the laboratory working on the most pertinent problem or one of secondary usefulness?

(4) Could not management and operational, as well as research, needs be enhanced if manpower flow exists from research to operations, or if there were an exchange of personnel between research establishments and operations even on a short time basis?

(p. 120)

Evaluation of management and productivity of Federal research programs (Peyton)

An examination and evaluation of the management and conduct of successful research programs and of those which have fallen short of desired objectives may be helpful. An attempt should be made to determine why large variations exist in the productivity of research projects, even when supported by the same agency, let alone by different agencies. It is possible that administrative and operational improvements in research programs and research contracting will result in greater economies than would have been obtained through mere elimination of overlap.

(p. 1033)

Management of Federal research and development (Schairer)

It is my belief that the Federal program in the area of research and development is well managed, effective and worthwhile. Of course there are many areas that can be improved. In my experience, the civil servants administering the Government research and development program are able and dedicated and seldom are motivated by interagency rivalries. I have always found a very healthy climate of cooperation between Government agencies at the working level. My greatest concerns about the management of Government research and development relate to the very great dangers which are inherent in permitting any one agency or individual too much authority over what should not be done. In research it is axiomatic that anything new will start as a minority viewpoint and will have to fight its way for many years against more popular viewpoints before its value is recognized. We must not make it too difficult for new ideas to emerge and come to fruition. Presently there are very great pressures in our Government to reduce the number of competing programs and to make it difficult for new ideas to be tried out. I am sure we will get more return for our money with less unification of decision machinery.

In concluding, I would commend to you that the civilian advisory committees in the many special areas of Government activities are probably the best possible way of ensuring that Government activities are coordinated, well managed, and have progressive goals.

(p. 1037)

Management of Government research, with particular reference to applied R. & D. (Weinberg)

(*a*) Need for competent managers is of prime importance and deserves serious consideration by the committee.

I cannot stress how much the competence of our research and development managers influences the effectiveness of our research and development. With competence in technical management we will, on the average, get our money's worth; without competence we will waste our money. It is as simple as that.

(*b*) Improving the caliber of managers:

(1) Pay them more.

In my opinion, this is probably the most important single action that Congress can take to improve the efficiency of its vast applied research and development effort.

(2) Devise a scheme whereby managers from contractor establishments can be utilized by Government agencies for an indefinite period.

What is needed is a much freer back-and-forth flow between the Government and at least some of its contractor establishments than is now possible—a restoration if you will of the spirit and style of research during World War II. I realize that today there are many difficulties in achieving this relation; yet I believe it is ever so worthwhile, and that the Select Committee ought to address itself to figuring out how to make this possible.

(pp. 318–319)

Management problems in research programs (Rose)

Because our research programs are as vital as they are, how they are "managed" becomes very important. The philosophies on which they are based, the guidelines and principles flowing from these philosophies, the establishment of "requirements" for research by agencies, the allocation of research funds, the forms and methods of day-to-day administration, the ever-growing problems of exchange of scientific information resulting from research, and the need for continuous evaluation of research findings are some of the broad aspects of management that are of crucial importance.

(p. 788)

Means of achieving maximum effectiveness and minimum duplication in R. & D. programs (Haughton)

(1) Good communication among all involved groups, within the company and in Government agencies

The role of the technical and scientific societies here is important and the committee may find it valuable to examine their part in the general communications problem in more detail.

* * * more complete communication with other research workers in universities, government, and industry has an important consequence in lack of duplication. Our own research can be integrated with that of the other laboratories so as to make a coordinated attack in a new technological area, with important gains in economy.

The results of our research are widely and openly disseminated. We published over 500 papers in scientific and technical journals last year.

(2) The rapid recognition of applications of basic research

Our large number of small independent research and development projects is aimed at rapid recognition of applications of basic research.

The Russian sputnik showed us how easily we can be caught napping by a country which is obviously capable of recognizing and making the most of a technical advance.

We should remember that the United States does not have a monopoly in research. * * * Our one important asset is the rapidity with which we can recognize and utilize the fruits of research, made possible by close ties between industry and government research teams. I regard this as a significant national asset; and I believe that this committee will perform an important service by setting as an objective a streamlining of its functioning, a more rapid and effective application of research discoveries to national needs.

Our European friends are showing a recognition of this same need for rapid research application * * * strongly supported by their national laboratories. * * * it points up a major problem in research management for this committee's consideration—how to obtain the most immediate advantage from our research programs.

(pp. 101–103)

Need for reexamination of Government administrative procedures (Calkins)

Government administrative and audit procedures need to be reexamined to see that they do not inhibit the independence and flexibility which must be conditions of creative research. Government research policies should not be so cumbersome as to multiply the administrative and financial burdens of the research establishment that seeks to make a contribution with Federal funds.

(p. 914)

Policy on termination and redirection of research programs (Haber)

Both Government and industry should develop a policy of encouraging early termination or redirection of programs that become unpromising rather than phasing them out over a period of time. Both Government and industry management should announce and maintain a policy of encouraging, as a sign of competence, timely recommendations to terminate programs for sufficient reason.

(p. 607)

The possibility of scheduling research (Collbohm)

In development you can usually establish schedules and have some chance of meeting them. You cannot, however, schedule "inventions," and in exploratory development you may know what you want to do, but since you may not know how to do, you may have to make unscheduled inventions.

(pp. 724, 730)

Role of the Government laboratories in management of applied research (Weinberg)

I think that the large Government laboratories, such as the National Laboratories, of the Atomic Energy Commission, the National Institutes of Health, or the Bureau of Standards could and should be drawn into the management as well as the conduct, of Government applied research and development to a much greater extent than they now are.

Since the establishment of these laboratories, they have been separated from their parent agencies and—

layers of functionaries have sprung up, for good and sufficient reason, between the scientific competence in the laboratories and the Government agencies.

Their energies and talents are not now being utilized to the fullest extent on Government research strategy.

I do not know in detail how to bring this about. I believe it is a matter that your Committee can well address itself to.

(p. 320)

Supervision of research (Haller)

Supervision by the procuring agency is necessary to ascertain that Government funds are spent wisely, but the challenge is to find the proper balance in directing and measuring the scientist's work without unduly interfering in the scientific process. Primary emphasis should be placed on the selection of the most qualified contractor, for if competent people have been selected for the project, the researcher can be permitted to work with a minimum of direct supervision and reporting.

Supervision should stop short of interference.

(pp. 333, 336, 337–338)

C. Specific Problem Areas

Difficulty of fixing responsibility, particularly with respect to long-range projects (Webb)

The Administration and agency which must see a project through to completion, and sometimes failure, may not be the same ones who made the initial decision to undertake the project. The Centaur booster is a case in point.

It was started prior to the formation of NASA [National Aeronautics and Space Administration], transferred into NASA with part of the control retained by the Air Force for a certain period of time after the transfer, and there was a period when it was very hard to determine exactly who was responsible.

(p. 84)

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Dispersal of research resources (Shaw)

USDA has found it difficult to effect greater concentration of research at more centralized locations in the States, although in the past 5 years the Department has closed down 72 field locations.

* * * We recognize that field stations manned by one, two, or three scientists are likely to be less effective than if these same scientists were located in a larger research community. Our Department leaders in cooperation with interested groups of State experiment station directors have, for the past five or more years, devoted a great deal of effort to exploring the possibility for greater concentration of research at fewer locations. * * * We are hopeful that we can work out plans for greater concentration of research. For the same money now spent for research at scattered locations, we could develop centers in the States where groups of scientists with more adequate support could do a more effective job of research on regional and national problems, and at the same time provide a valuable training ground for graduate students.

(pp. 206–207)

Importance of good management and technology (Webb)

The General Accounting Office estimated a loss of about $100 million was incurred on the $500 million which National Aeronautics and Space Administration has spent on the development of the Centaur booster rocket.

All we have learned with the most unfortunate experiences related to this particular rocket, where a good job was not done in all of the management or the technology, is a net gain in terms of the value. It will be worth more than we paid for it.

Now, I think if I could make any suggestion, and I believe it is along the line that you are thinking, we must tighten up and make sure we make as few mistakes as possible, but still keep moving forward.

The GAO report, here referred to, was published about a year and a half ago, and the mistakes listed in it had been corrected about a year earlier as stated in the report.

(pp. 84–85, 91–92)

Lack of modern facilities (Shaw)

In both the Department of Agriculture and in cooperating State institutions, the lack of modern facilities acts as a limiting factor to research. To fully modernize these facilities will require very substantial sums. This problem is aggravated by the fact that the capacity of many land-grant colleges to accommodate cooperating Federal scientists is declining, because of increased student loads on facilities. Recent enactment of Public Law 88–74, authorizing Federal grants on a State matching basis for erection of research facilities at State agricultural experiment stations affords possible relief; no funds have yet been appropriated under this new authorization.

(p. 207)

Modification of the executive branch organization for science and technology (Killian)

The executive's scientific advisory body, which has been evolving and growing, needs more senior scientific personnel if it is to function adequately. The duties of the President's Scientific Adviser may have to be split up, and the recent appointment of a Deputy Director of the Office of Science and Technology was a good idea.

(p. 760)

Problems involved in research based on a variety of disciplines (Foster)

Unlike the research programs of many agencies, ours [Arms Control and Disarmament Agency's] involves a variety of disciplines. Our programs encompass not only the physical and biological sciences, but political science, economics, social and behavioral sciences and, very importantly, most facets of military technology. Many of our problem areas involve several of these fields at the same time. These must be investigated on a multidisciplinary basis. This fact creates significant difficulties in managing programs and in finding qualified personnel or organizations to carry out the research. [Several examples are cited.]

(pp. 771–772)

D. Fragmentized Versus Centralized Organization of Federal R. & D. Functions

Centralization of Federal agencies supporting research (Long)

Most academic people believe that the multiplicity of agencies supporting research is a good thing, because support by agencies interested in what is done leads to better supervision and control and "just more thoughtful administration."

(pp. 478–479)

Centralization of Government research programs (Dickey)

The arguments in favor of further consolidating Government research programs are outweighed by the advantages of the present multiagency approach which tends to promote breadth, flexibility, and "openminded" competitiveness.

(p. 1077)

Centralized direction of research (Teller)

We have a wonderful system by which both the Federal Government and private institutions can support these activities [universities in the training of scientists and making loans to students]. I see nothing wrong in principle with this arrangement. At the same time I know that when support is given, one should carefully consider the limitations that the support imposes.

The worst thing you can do to science is to try to direct it. If support should mean centralized direction, then I am opposed to support.

* * * * * * *

[Support of specific areas of learning makes good sense.] The central direction that I feel I must be opposed to is one which tries to predict in detail what will come out from one and from the other field of endeavor. I know that I am talking here about a difficult situation. You cannot give support without some direction. You must not overdo the directive, and there is a human tendency to overdo it.

The way to get out of this trouble is partly to be conscious of the danger, and partly it is by a multiplicity of the supporting agencies.

[In reply to a question as to any examples of Federal Government controls in areas of Federal support, the witness replied:]

My general impression is that so far the controls have been provided gently and reasonably. It is however, a point which I would like to continue carefully to watch. There have been arguments made in the name of efficiency of gathering all these supports into a minimum number of agencies, if possible into a single agency. This I think is dangerous.

(pp. 951–952)

Centralized Federal control of research (von Braun)

* * * I do not recommend the establishment of a Department of Science, or any other agency, that would exercise control over the Federal research program. I agreed completely with Dr. Jerome Wiesner when he said his most important job as Presidential Adviser was, as he put it, to protect the anarchy of science. Pure science is one area that must regulate itself. * * *

(pp. 518, 530)

Diversity of agencies administering grants and contracts for scientific research (Berkner)

Experience has shown the current system best fitted for the United States, and it is outstandingly successful. "Diversity is the essence of our American system."

The impressive advantages of the system of diversity are:

(1) Each agency is kept close to the advances of science affecting it and is influenced by participating in that activity. This counteracts the tendencies toward obsolescence and produces youthful, virile attitudes.

(2) Since each agency functions in its own areas of interest, it comprehends the research it administers, and this ensures efficient administration and effective evaluation.

(3) Since the form of regulation varies from agency to agency, American science has had the opportunity to experiment with various forms of administration and, from this, steady improvement has occurred and bureaucratic authoritarianism kept minimal.

(4) Diversity of administration is less susceptible to scientific "orthodoxy," and broader aspects of science are recognized for their work. This gives us great national strength.

Of course, we must guard against dangers inherent in the diversity of administration:

(*a*) Danger of unnecessary or unplanned duplication is enhanced.

(*b*) Since no one agency has responsibility for all science, serious gaps in support planning are inevitable.

(pp. 435–436)

Executive branch organization for R. & D. programs (Furnas)

The best apportionment of finances and effort among the Nation's many R. & D. needs is a perennial problem, and will never be finally solved. The Office of Science and Technology is "the best source of guidance in this very crucial matter."

* * * An often-proposed new Federal Department of Science is not the answer. This would mean adding another major agency which would probably only hinder progress.

(p. 1010)

The executive departments as agents for accomplishment of the Federal R. & D. program (Wenk)

It is important to remember that the authority, missions and roles and responsibilities of individual departments constitute the predominant basis for accomplishment of Federal research and development programs, and should continue to do so. Each department, with its own special and complex requirements, must be free to sponsor imaginative and creative research if its development programs are not to become sterile. Some diversity in administrative style

must also be expected. To insist that Government processes in all agencies be identical for the sake of administrative tidiness might seriously damage the effectiveness of the R. & D. operation. Nevertheless, a continuing process is required which facilitates integration of individual agency efforts under common policies, internally consistent and coordinated in execution.

In serving the President, the Federal Council on Science and Technology has this responsibility.

(pp. 219, 243)

Fragmentized versus centralized approach to Government organization for research (Weinberg)

[In answer to an inquiry whether the Federal Council for Science and Technology and the Office of Science and Technology did not seem to be encouraging fragmentation of research effort, the witness stated that] the present organization appeared to have the potential to

achieve most of the good things that you hope might come out of a single Department of Science, without running the risk of bringing all of the difficulties that would be attendant upon the establishment of such a Department.

(pp. 329–330)

Proposed centralization of all Federal science and technology in one agency (Wiesner)

* * * We believe, however, that while some regroupings of Federal scientific and technological functions may prove to be feasible, a comprehensive Department of Science * * * would isolate science and technology from intimate involvement in the operating missions of the Federal agencies. Furthermore, it is doubtful that any single agency could achieve the breadth of competence, the mastery of detail, and the diversity of perspective that a single directing mechanism for science would require.

The Office of Science and Technology has developed tighter planning, decisionmaking, management and coordination controls and is following up on the recommendations of several studies with respect to improved procedures and information sharing.

(pp. 264, 273–274)

Soundness of method of "fragmentizing" a research effort among several departments and bureaus (Wenk)

(The witness replied affirmatively to two questions from a member of the committee: (1) Is this method sound? and (2) is the concept under review by the Federal Council for Science and Technology?)

There are several alternatives when a program or area is identified as in serious need of stimulation: (1) A new agency can be formed, as was done in the case of the space program. (2) In the case of a program, such as oceanography, with a background of long historic development, related specifically (as the space program was not) to several different agency missions, a new agency is not established. (3) Primary responsibility can, however, be transferred from various agencies and vested in one department or bureau. While the effectiveness of research might be improved under these plans (2) and (3), it is probable that in the long run you would weaken the contribution of that research to the accomplishment of the agency mission.

(pp. 253–254)

E. In-House and External Research Facilities, Choice Between Use of

Balance between in-house and external research (Denney)

Another question concerns the balance between in-house and external research, which vary in cost and have varying advantages. Clearly, tremendous benefit is to be gained from the interplay of research within the Government and research under contract in private hands. Is there some way of determining in various fields how much research should be allocated to each kind? The need for security and speed may require in-house research, whereas use of skills not available in the Government or difficult to retain in Government may call for external research. Can these categories be broken down further?

(pp. 184, 194)

Choice of suitable research agency (Heald)

The committee might inquire into the choice of agency to do research. It should be questioned whether research is to be done by a Government agency or contracted out, and, if the latter, to whom.

There is danger that channeling too much research through one agency (either governmental or nongovernmental) will tend to make research too uniform. Coordinated research among various agencies might constitute a check against "an excessively homogenizing effect on research."

(p. 387)

Division between Government and private research (Denney)

One field of inquiry should be whether some fields are particularly suited to Government or particularly suited to private research. There may be some subjects in foreign affairs research, for example, into which the Government should not go.

Some people contend that basic research should be left entirely to the openminded, unhurried, quieter ways of private research, but others contend that basic research benefits from the purposeful drive of Government programs. Speculation peering into the distant future at first sight appears a task suited to the academic atmosphere, but we can ask whether broad views and keen insight do not flourish at least as well under the urge of operational requirements. While generally historical research may be done more practically outside the Government, even historical research sometimes gains substance and sharpness when addressed to specific questions within official organizations.

(pp. 185, 194)

In-house and external research (Foster)

I strongly believe that any Government research program should be carried out using both in-house capabilities and those available through contracts and grants. The operation of the Arms Control Agency requires in-house competence in the fields in which we must conduct research. This is necessary in order to use intelligently the products of the research and to ensure that external research is both competently carried out and responsive to Agency and overall governmental needs. I believe that an organization gets out of its external research programs

no more than it puts in. The contracting out of a problem with little or no supervision or contact between the Agency and the contractor until the finished product is available will not produce much of value. Competence on the part of those within an agency who manage research is absolutely essential.

In addition, internal research studies are needed to support, on a continuing and timely basis, the current activities of the Agency. Contractors are less capable of furnishing this sort of service than are the Agency personnel. But the Agency, as a practical matter, cannot carry out all, or even most, of its research in-house, because the staff is too small. It would be absolutely impossible to staff the Agency with all the expertise it needs in the wide variety of complex problems with which it deals. Also, any organization requires stimulation from without, as well as independent analyses. Such stimulation can best be provided by research contracts or grants to academic or nonprofit institutions.

(pp. 772–773)

Proper balance between research within and without the agency (Calhoun)

Another characteristic which I have noted is the high percentage of in-house research in Interior programs. There is need for consideration of the balance between research within and without the agency. How much of the necessary research should be by contract? How much should be in-house?

Achievement of maximum efficiency and effectiveness will recognize that ideas and contributions are to be sought from all creative sources that have a potential contribution toward the research at hand. Research has become in fact an industry of its own. Part of the excellence of this industry lies within the Federal laboratories, part without. As with all other types of need, therefore, research should be purchased where the gain will be maximum. Within Interior, the legislative authority does not exist for all bureaus to do this.

(p. 120)

The purpose of the nonprofit, nongovernmental research corporation (Collbohm)

[The witness replied to a question as to what makes such organizations more efficient than the same sort of organization located within the Government.]

The Rand Corp. was set up because it was considered desirable for the Government to have the kind of advice it had had during World War II.

* * * It was determined at that time even that we could not set up the right kind of environment in the Government, either Civil Service or in the military departments, to attract the type of people that we thought were necessary. We had to be able to set up an environment that was more attractive to these people.

There are many other factors. For example, in a nonprofit or nongovernment institution, it is much more likely that studies can and will be made on subjects that go counter to current positions or policies. Yet these are the very things that need to be done. * * *

(pp. 727–728)

The usefulness of private research institutes in the Federal service program (Thomas)

[The question was raised whether the Government would be better advised to conduct more of its basic and applied research through private institutes, rather than as an in-house function within an agency]

* * * I earnestly believe that the research institutes * * * are extremely effective institutions for doing particular kinds of research. And, of course, I think that their effectiveness is such that their work should be increased.

You asked me to say this * * * and this I think is true. To that extent I think that the Government would be well advised to use these institutions more than they do.

In addition to private research institutes, such as Battelle, Southwest, Stanford, and others, "I think that Federal funds spent in the universities in general is very, very well spent. In addition to getting information, it stimulates education, 'a very important byproduct.'"

(pp. 417, 418)

F. Grant and Contract Processes

Adequacy of coordination in administration of extramural grants by HEW (Jones of HEW)

The term "adequate" is hard to define. I think we do have an adequate mechanism for avoiding unnecessary duplication. I think we need to continually review our administrative processes to improve. This is what has been going on for the last few years with great effort. I think we have achieved in the last 2 years a great improvement in the administration of these funds.

(p. 555)

Effects of large "prime contracts" as used by certain Government agencies (Steimke)

In writing this type of contract, it is the expressed hope that numerous subcontracts will be awarded. The procedure itself is intended to minimize the legal-administrative workload, but, in reality it "shifts the responsibility and control off from the agency which should retain responsibility." The extent of subcontracting is left up to the prime contractor, who tends to make sure that his own inhouse research effort is fully used or expanded, with the result that subcontracting is minimized. More than this, the work done by all participants is produced under the prime contractor's name, thus enhancing his prestige and assuring him of an even better position from which to be selected for other prime contracts.

(p. 616)

Government regulation of R. & D. (Kistiakowsky)

The current trend toward more governmental regulation of grants and contracts tends to restrict the freedom of action of the grantee or contractor, and to put more detailed operational controls in the agency staffs who are more remote from the actual research activity, and who respond slowly.

Although certain reports have disclosed several instances of lax administration of grant funds, there is no evidence of misappropriation of public funds for personal gain in nonprofit institutions.

Rather than increasing agency controls a more sound reaction would be to insist on

* * * a greater sense of responsibility and more effective self-policing methods by the institutions to which investigators belong and to which grants and

contracts are made. This is in the spirit of our great democratic tradition of decentralization of control and should not be reversed because of isolated cases of irresponsible actions.

(p. 612)

Imposition of rigid restrictions and regulations affecting the use of grant or contract funds (Eisenhower)

* * * an institution (and the scientists involved) receiving support from the Government must be strictly accountable for the proper expenditure of those funds. * * * I do not challenge the need for a careful examination of present practices and * * * such changes as may be indicated to assure the prudent use of Government funds.

My fear is that reaction to recent efforts of granting agencies to correct isolated abuses may cause the pendulum to swing too far in the direction of unnecessarily restrictive regulations.

I hope the sponsoring agencies will adopt only those regulations and restrictions which are necessary to provide assurance that Government funds are being spent wisely, economically, and in harmony with legislative authorizations.

If Government policies forced scientists to spend more and more time and effort on "time records, inventories, periodic reporting, and the observance of other regulations and correspondingly less upon productive research," the losses would be greater than those which might develop from a few minor loopholes.

* * * Doubtful situations should be resolved in favor of the freedom of the scientist to pursue his inquiries in an appropriate academic atmosphere. * * *

(p. 996)

Modification of Federal administrative regulations (Rose)

There is need for standardization and abbreviation of administrative regulations and procedures. Total consistency may be too much to ask but progress toward consistency could be made through this committee's work. Present detailed and widely varying regulations waste the time of researchers and administrators in the university.

(pp. 791–792)

Need for improvement in administration of Federal funds for research (Aderhold)

Criticisms of institutions receiving funds from Federal sources for research are

* * * that processing of proposals and grants, and the administration of funds are complex and time consuming, to the point of necessitating additional personnel.

[A] well-organized but flexible system of support must be devised if funds for research are to be equitably distributed to produce the greatest effect. * * * Again, I would cite the successful combination of State and Federal support where our experiment stations are concerned as a guide in establishing policy for cooperative research programs.

(p. 907)

Negotiation of contracts and grants (Heald)

The committee might study whether sufficient care and time are spent in the initial stages of making grants and negotiating contracts.

(pp. 387, 403)

Obligations in utilization of grant funds (Berkner)

Current concerns [arising from the occasional mismanagement of grant funds, or their misdirection] place a heavy onus on the scientific community to recognize and accept its obligations in the use of public funds. It is a tribute to the dedication of scientists, and to the institutions of which they are a part that so little mismanagement has occurred.

Over recent years the grant instrument has developed without explicit legal interpretations on its use, but with implicit understandings between the Federal agency and the grantee. Research problems have been formulated in broad terms to give latitude to the individual scientists. The heart of the present debate concerns not whether, but how far, an investigator can be permitted to change his directions before the original considerations which led to the grant award can be regarded as no longer valid. This is the point of primary concern for congressional committees and granting agencies as well.

Scientists and their administrations should recognize the need for a common set of principles to be observed in the utilization of grant funds, and see that these principles are promulgated, understood, and endorsed by researchers throughout the Nation. This could avert the need for restrictive legislative action and permit the necessary flexibility. The scientific community, perhaps through the National Academy of Sciences, could develop such a set of principles. The key objective should be to define clearly a mechanism whereby scientific responsibility is exercised by the scientists themselves and their institutions.

Overregulation would inevitably destroy the creativeness and the present productivity of our science. The cost of administering more detailed regulations might exceed the cost of a rare case of mismanagement.

(pp. 432–433)

Procedure for making research grants (Kemeny)

The procedure used by the National Science Foundation is most likely to put Government funds to the best possible use. This consists of having experts in the field judge the value of the research and letting NSF make the administrative decisions.

(p. 1069)

IV. DUPLICATION AND COORDINATION OF R. & D.

A. Nature of duplication and its control
B. Undesirable duplication
C. Need for better coordination of R. & D. activities
D. Dangers of excessive coordination
E. Coordination of multiagency R. & D. programs

A. Nature of Duplication and Its Control

Coordination in basic research (Waterman)

The measures by which researchers in the basic research field seek to avoid needless duplication by keeping track of current work going on in particular fields result in a "high degree of coordination in overall plans."

It would be my personal opinion that the basic research program of the Federal Government is about as well coordinated as any that you would find. * * *

(pp. 812, 821)

Control of duplication (Vickers)

There is a built-in self-control on the conduct of basic and applied research. Scientists have no motivation to follow behind or merely duplicate the work of others. Industry in a competitive economic system can price itself out of business by conducting expensive research and development that only duplicates and does not give it a favorable position over its competitors. Properly managed duplication may be advisable in Government and in industry, for example, to evaluate different solutions, to generate different ideas, and to test relative rates of achievement. However, every effort should be made to assure that what duplication exists is known and understood to be advisable.

Self-policing effect is greatest when full communication and freedom to choose is present, and is least when secrecy is imposed and outside controls instituted.

(pp. 1065–1066)

Duplication (Berkner)

Some measure of duplication is imperative. * * * All great scientific discoveries have come as a consequence of the interaction of several great minds viewing problems with different insights and skills. To eliminate duplication would be fatal—the problem is to develop the delicate sense of how much duplication is enough, and, within this limit, how expenditures for facilities can lead to optimum results.

While Congress rightfully inquires into apparent and real duplication of basic research effort, if only a dollar yardstick is applied, important opportunities for real breakthroughs could be stultified. Duplication is the handmaiden of diversity with its natural selection of the best, and, just as in business, competition in research is the essence of excellence and of progress.

Some duplication is justified under each of three objectives:

(a) To permit a problem to be attacked in different ways by investigators with different skills. Scientific problems are usually solved by the creative and competitive interaction of several individuals working in different environments.

(b) To provide for graduate training of scientists in sufficient numbers. The novice must start on known ground before intelligently probing the unknown.

(c) To bring into each community a sense of scholarship in each of the major areas of science.

Our most serious failure, today, in capturing innovation as the new resource, has been the failure to extend the scholarship underlying this resource to about half of our population. This access cannot be acquired by "book learning" alone, book learning distant from major centers of research; it is opened only by actual participation in the research process itself. Only in this way can the useful concepts of innovation emerge for the full benefit of all.

Of course, duplication can be pushed beyond the bounds of reasons. If allowed to go beyond the fulfillment of the above objectives, it results in waste of money or, more serious, the deprivation of more justifiable research.

On the other hand, overcontrol of duplication can prevent the infusion of new blood into the field when, through lack of competition, its participants can deteriorate into a smug, second rate, and unimaginative "priesthood."

The problem is to develop a reasonably objective and sensitive judgment, based on criteria of what is or is not improper duplication. The judgment and the criteria may differ for different fields of research.

On the whole, granting agencies have exercised excellent judgment in the extent of justifiable duplication, and if they have erred it has been mainly on the side of too much restriction, particularly in encouraging scientifically underdeveloped metropolises to improve their capability. Congress might inquire into this matter, for no area can afford to remain isolated from the major resource of innovation.

The President's Science Advisory Committee through panels, or the National Academy of Sciences, might review the research activities in the several scientific fields in the light of the agreed criteria to ascertain whether duplication is sufficient or excessive, and report to the Nation.

(pp. 425, 430–431)

Duplication (Calkins)

Duplication occurs much more in development than in research. Though instances of duplication in research may perhaps be found, it would be surprising if they represented wasteful expenditure in fact.

(p. 911)

Duplication (Furnas)

The best policing method to prevent unnecessary duplication is through full interchange of information among scientists. The scientific community is adequately self-policing in this matter.

(p. 1010)

Duplication (Haller)

Duplication is not necessarily bad because it may be helpful to attack a given problem from several different approaches. The committee should be careful to identify the type of duplication which may require a greater control; i.e., duplication of the same methods for solving the same problem.

In examining individual programs, the committee will need to be concerned with how they fit into the total picture.

The nature of scientific inquiry is such that many related aspects of a total problem need to be studied separately. Very often this will lead the researcher into areas of inquiry which are perfectly relevant, but which to the layman bear no causal relationship, and therefore appear ridiculous. * * *

You cannot always learn the relevance of an R. & D. program from its title. I suspect that some of the criticism of various Government-sponsored research programs results from a failure to fully understand their relevance.

Any group reviewing research programs should look at them in their total context: in the light of objectives and relation to other work.

(pp. 331–2, 335)

Duplication (Haworth)

[In reply to a question concerning duplication of research, and "any conflict, any waste, any extravagance that might be eliminated by better administration," the witness stated:]

In research, especially in basic research, the problem of duplication is not one that one really has to worry about, for the simple fact that [with] basic research the results are fully published, and all scientists can see them.

Now no scientist wants to come along a little later and do just exactly what someone else did and already got the credit, so that it is a self-policing thing. * * * Oh, I don't mean occasionally somebody doesn't fail to know that somebody else is doing something, but any duplication is trivial.

In development, one has to watch much more closely. There is not so much general knowledge about the devices which are produced; many of them are produced for special purposes and are not of general interest to many people; for reasons of military security and of the companies' need to preserve secrecy concerning their private development results, the chances of duplication are greater than in the case of basic research. There probably is some duplication but "I don't think there is very much though with Federal funds."

[A member of the committee returned to the witness statement that in the field of basic research there is self-policing which prevents duplication. He replied:]

The Government, the universities, and industry recognize that in basic research the scientist must be allowed to determine his own course of action in pursuing his objective. "No individual scientist is going to waste his time duplicating the work of someone else."

[A member of the committee asked the witness, "In effect then you are telling us that a private company doing basic research will collaborate and cooperate with other scientists in other private industries with which they are in competition, and widely disseminate their views among the scientists?" The witness replied:]

The results of basic research I think almost, if not entirely, without exception * * * are published in the scientific journals, and are available to everyone. Now as you move toward development through applied research and toward development, this becomes less and less true, of course. I did say, you will remember, that there may well be duplication in the development of devices, and maybe there is in * * * applied research.

We do basic research in order to get some application of it, and that is

one of the reasons that an industry or the Federal Government supports basic research. But it is not the reason that the man does basic research. * * *

In other words, we support basic research in a general sense because of application, but we don't usually do specific basic research because it may have a specific application.

(pp. 48–49, 54)

"Duplication" and "overlap" in Government R. & D. programs
(Harrar)

[If the term "duplication" is used to imply] that there are many individuals or groups of scientists in different programs assigned to similar research projects, then I think little duplication exists. To have many investigators working independently on important problems * * * is a healthy situation. * * *

If, on the other hand, "duplication" is taken to mean that there are perhaps more agencies than necessary to accomplish stated tasks, then I would think this possibility merits careful examination. Bureaucratic and other agencies often manifest the primordial urge to proliferate. It is possible that, within a mammoth structure with a multiplicity of responsibilities, the organization may get out of balance with purpose. Thus, I would think that it would be a healthy exercise to carry out a detailed and competent examination of the Government involvement in research and development to assure that there is a reasonable balance between objectives and efficiency. This might result in the designation of a high-level clearinghouse (e.g., the Federal Council for Science and Technology) with both responsibility and power in matters relating to the creation of new agencies and the rate of growth of those already in existence. This body might also function to determine where consolidation is indicated in order to achieve greater economy and efficiency without loss of progress.

In my opinion, "overlap" is rather commonplace and is to a high degree inescapable in Government and, indeed, in other sectors of research and development. Unless overlap reaches the point at which it results in unnecessary competition, and, in fact, duplication of effort, I do not think it is unhealthy. On the contrary, some overlap provides areas and opportunities for cooperation and the exchange of ideas and information useful to groups with related interests but different objectives. * * *

(pp. 1017–1018)

Duplication and coordination of research (McConnell)

In general, I do not believe that a significant duplication of effort exists in basic research. One stringent curb on duplication is obtained through the natural process by which a scientist-teacher disseminates new knowledge and plans for further studies, through oral presentations at professional meetings attended by his peers and written treatises published in the scientific journals. Duplication of another's work, even though inadvertent, is not very satisfying to a researcher.

* * * To be sure, some overlap, as distinguished from duplication, in the investigation of many problems exists and is in fact unavoidable. This is true because of the mutuality of interest by researchers in various phases of the same general problems. In a few cases intentional duplication may be desirable, primarily because of the expected importance of and urgency for a scientific breakthrough in a chosen area. The basic question then is not so much the cost of duplication per se but the cost of the effort in terms of the value of the end result and the time when it is needed.

On the matter of coordination, it is my understanding that listings of all proposals, grants and contracts are circulated among the various sponsors and that research administrators in different agencies serve along with university faculty on each others' advisory and evaluation panels.

One of the safeguards against unwarranted duplication of effort and research on trivial topics which is built into the present system is the use of nationally recognized faculty specialists on evaluation and advisory panels and as temporary Government research administrators while on leave from their home institutions. Unfortunately, the number of faculty utilized for this latter purpose appears to be declining, relative to the number of professional research administrators.

(pp. 863–864)

Duplication and waste in research programs (Bailey)

Duplication does not necessarily mean—in fact can hardly mean—waste in the area of basic research when results are being communicated freely.

[This is true because] duplication in another laboratory is often a necessary replication essential to establish definitely the truth of the first observation. This is especially true of major contributions. Such duplication is not wasteful. * * *

In the applied areas, duplication may also serve very useful purposes. Duplication of a type can be a very healthy competition which results in * * * vastly improved products. * * *

Another obvious aspect of duplication with which you will be concerned is that which might result in the overlapping of areas of interest and activity between Federal agencies. In anything like our present structure—which we think is basically sound—some overlapping is inherent. * * *

(p. 873)

Duplication in applied R. & D. (Schairer)

It is advisable to distinguish between duplication, competition, and progress. Sometimes different methods may be employed, all with the same objective. The results may complement rather than duplicate each other.

Sometimes parallel competitive effort results in savings and benefits far in excess of the development costs.

In this connection I would reiterate the very strong belief of Boeing management that the American public would get much more per Government dollar expended in promoting the supersonic transport if two competing developments were encouraged. It seems to me that governments whose policies support competition always win over governments who have "chosen instrument" policies.

(pp. 1035–1036)

Duplication in basic research (Getting)

In basic research, there are literally hundreds of scientists working on some problems, and it is through their combined efforts that progress comes. The word "duplication" as it is often used in the governmental budgetary sense has little meaning when applied to basic research.

(p. 1012)

Duplication in basic research (Schairer)

I feel certain that you can satisfy yourselves that no basic research worker would ever knowingly duplicate someone else's research except as a means to verify it and progress to new knowledge.

(p. 1035)

Duplication in Government research (Haber)

Controlled redundancy is advantageous in that it affords different approaches to a problem and thereby increases the chance of at least one approach being successful. Yet it is useful only insofar as it is recognized and controlled. An effective data retrieval system is certainly needed in this connection.

(p. 607)

Duplication in Government research programs (Murray)

Any question of duplication should be considered in relation to the seriousness of the problem being researched. It can be wise and even necessary in urgent or dire situations to assign duplicate, or even triplicate or quadruplicate, research teams to identical problems. * * * Another form of apparent duplication, which isn't real when understood, is related to the old adage of doing a job yourself if you want it done right. * * * This is why I think it is logical and desirable that many of our Government agencies should do research in the same broad areas or disciplines. Seldom, if ever, do their efforts even approach undesirable duplication. * * *

[Considering the subject of duplication from the standpoint of the researcher—] Scientists do not wish to repeat the work of others and take great pains to try to avoid this. * * *

The publication of research is the means by which duplication is prevented. Government can aid by increased emphasis on systems for indexing, lending, and purchasing Government research reports. Scientific meetings cover every field of science and technology. Such exchanges of results and scientific information provide for prompt availability of knowledge to all concerned, with little likelihood of undesirable duplication.

(pp. 455–456)

Duplication in R. & D. programs (Hollomon)

The problem of evaluating R. & D. that faces your committee is not one of excessive duplication.

Duplication in technical programs is to be expected because

different people will take different tasks and research is generally expected to be inefficient. * * * Furthermore, in certain instances, deliberate duplication is desirable, especially in the early stages of exploratory research either to reach the desired goal quicker or to save much larger sums that are required for the development in the later design state.

(pp. 294, 299, 303)

Duplication in research (Bush)

Although duplication in research can involve waste, on really important problems duplication is both inevitable and necessary for rapid progress. Competition among scientific groups produces outstanding researchers.

(p. 461)

Duplication of research (Rose)

Finally, I strongly suggest that the committee approach the matter of duplication of effort in a cautious manner.

More important than the problem of unnecessary duplication of effort is getting the "concentrated and parallel effort" necessary to advancement in science.

(p. 793)

Duplication of research (Schairer)

Duplication should be considered separately for basic research, for applied research, and for development.

(p. 1035)

Planned duplication in exploratory development (Collbohm)

In exploratory development (for example, development of air-cooled and liquid-cooled aircraft engines) where we seek a solution to important problems, we cannot afford to rely on a single approach.

*** * * Planned duplication may at times be desirable to be sure that we have at least one solution. If more than one turns up, we can choose the best benefit by the experience in arriving at each of them.**

In some cases what might appear to be duplication, either planned or unplanned, is really an evaluation of different programs, to determine which is most beneficial.

It would certainly be desirable to make decisions earlier than we do, before huge sums of money have been expended. One of the things Rand Corp. does is to make studies to be used by decisionmakers.

(pp. 724–726, 727)

Self-regulation of basic research, with specific reference to duplication (Seaborg)

Duplication in basic research activities is not necessarily bad, and is, in fact, often desirable. Confirmation of scientific work is essential, and enhances the value of the findings. * * * When several groups are known to be active in the same area of research, constructive rivalry sets in, analogous to competition in the business world.

Clearly duplication of effort toward the "rediscovery of knowledge that is already known" would not be long tolerated. Not only is there "absolutely no incentive" on the part of the basic researcher "to indulge in repetition," but also the detrimental effects of duplication upon the researcher's reputation in the eyes of his peers provides him with a "strong incentive * * * to avoid repetition of previous work."

At the present time the Atomic Energy Commission conducts very little classified basic research and, consequently, is not faced with the problem of duplication.

(pp. 67, 78)

Waste and duplication in research (Peyton)

While unnecessary duplication and overlap in Federal research cannot be condoned, duplication of research activity may, in some cases, be desirable and necessary to gain objectives sought.

* * * Particularly in the case of Federal research, apparent duplication may be the result of attempts to find differing applications of similar basic knowledge, Thus, such duplication may be intrinsically desirable from the scientific and technological viewpoint and for the successful accomplishment of a variety of objectives. We suggest that the select committee look at duplication and overlap in this sense, rather than in a more restrictive sense.

(p. 1033)

B. UNDESIRABLE DUPLICATION

Duplication (Thomas)

The committee has expressed concern about the matter of duplication of effort.

No one who has ever dealt with human enterprises would disagree for a moment with Mr. Elliott's statement that in a $14 billion enterprise wasteful overlapping and needless duplication are bound to occur.

* * * I would like to observe, however, that I know of no important duplication of research effort, per se. In fact no scientist wants to duplicate another's effort. * * * If such duplications exist, they arise out of the information and communications problem which is itself a subject of research designed to minimize these duplications.

There are, on the other hand, some obvious duplications that the committee may wish to do something about. One of the more important ones arises out of Government contracting procedures. I have pointed out that the Government controls the use of the available scientific talent through its expenditures. It induces a very considerable duplication of effort if the usual system of awarding contracts on the basis of competitive bidding puts scientists to work writing proposals requiring a great deal of thought and preliminary analysis—proposals that do not sell because perhaps a dozen others have written duplicates and only one can triumph in the competitive process. I have no rigorous method for estimating how much this duplication of effort amounts to; but if, as I surmise, it is more than 5 percent, we are, on the basis of a total budget of $15 billion, talking about $750 million—a not inconsiderable sum. Quite frankly I have no very constructive suggestions about how to solve this problem—except to make it the subject of a research investigation!

(pp. 411–412)

Duplication in applied research and development (Waterman)

Security restrictions in Government make it more difficult to detect duplication of effort in development projects than it is in basic research projects. Similarly, competition between industrial firms on development projects results in reluctance to make public the work going on. Thus, in applied research and in development there is a constant need to be alert to the possibility of undesirable duplication of effort.

(pp. 823–824)

Duplication in applied research or developmental programs (Seaborg)

Duplication becomes a more serious problem in applied research and developmental programs because "hardware is expensive, and duplication in its development—whether it be knowing or unknowing—is bound to be costly." Sometimes parallel efforts are deliberately undertaken in order to "assure the attainment of an objective on a short time-scale."

(p. 67)

Duplication in basic research (Waterman)

* * * One must realize at once that a certain degree of duplication is necessary, since an important research finding must always be checked by other observers, preferably using somewhat different techniques. The proper word to use for basic research is *undesirable* duplication, and again this is a matter which the scientists are most competent to decide.

* * * To attempt to duplicate unnecessarily the work of another researcher is to commit professional suicide. It follows that a competent research scientist or a panel of competent scientists in a particular field of science will know remarkably well the current work that is going on in the field, and will not undertake or recommend projects which do not have this original quality. This fact, which is commonly misunderstood, provides the greatest possible safeguard against needless duplication.

(pp. 812, 821, 823)

Duplication of research (Brown)

Although duplication can occur in research, it is not a severe problem, because it tends to be self-regulating.

Industrial companies, however, may duplicate each other's research and development and not be concerned over this so long as they are getting paid for it by the Government. Good management and control on the part of the sponsoring Government agency is necessary to avoid unnecessary duplication in such cases. Sometimes, of course, you can have desirable duplication and development.

(pp. 175–176)

Duplication of research and substandard research (Seitz)

The risks of duplication of work and of substandard work in the area of basic research are negligible so long as this work is published at scientific meetings and in reputable journals, exposing it to the scrutiny of professional critics.

The greatest possibility of duplication of research and of substandard scientific work occurs in areas where pertinent information is buried in laboratory reports or contractors' reports and is not available to be reviewed by competent scientists. This is especially true of classified material.

(p. 62)

Duplication of research efforts (Ewalt)

Since the National Institutes of Health are set up to give the maximum amount of independence to researchers and there is no overall play for forcing research in one direction,

* * * there is no efficient way to avoid duplication because if two men want to work in different places on the same problem and both are good men and the solution of the problem is important, who is to say that only one of them shall be given the grant.

Some of the questions which arise are:

Should research be coordinated at the national level?

Should the National Institutes of Health assess the needs for research, promote research in areas for which there are not applications for grants, and eliminate duplication?

Who should help NIH make such decisions?

Will it be done by panels?

Who will decide the relative needs for research?

(pp. 366, 369)

Methods of avoiding overlap (Halaby)

Whenever you have more than one person doing anything, there is a danger of overlap. I have heard it called uncoordinated duplication and unproductive overlap and unwarranted duplication.

The agencies are learning how to avoid overlap and there is more machinery than ever for coordination, but—

I am not in a position to judge whether it is adequate. I am sure you will be when you have finished this work.

The machinery for coordination is elaborate and intensive, but regardless of the superstructure the key is the individual public servant starting the project. The primary reliance ought to be on him to make sure that the project is necessary and has not been done before.

(pp. 130, 131–132, 136)

Possible duplication of skills already available in nonmedical professions, as a result of Government training grants (Ewalt)

While three research requests for optometric training grants were turned down recently, two training grants were given by the Neurological and Sensory Diseases Services Branch of the Public Health Service to medical institutions for the purpose of training ophthalmic technicians. These grants would cost $300,000 over a 5-year period and train 20 people at most. There is a serious question as to what these trainees could do, and the curriculum—

modeled in some respects after that of the schools of optometry as they existed 25 years ago, would not qualify the graduates to function other than directly under the supervision of a licensed physician or optometrist. It would appear to be the height of folly for the Government to embark on this type of training program and at the same time deny funds for postgraduate training of optometrists in fields of vision research.

(p. 369)

Undesirable duplication (Seaborg)

The important thing to remember—in basic as well as in applied research and development—is that undesirable "duplication" occurs only when plans and results are not freely communicated.

(p. 67)

C. Need for Better Coordination of R. & D. Activities

Adequacy of overall coordination of research and development (Waterman)

[In response to a question whether the present organizational structure for coordination was sufficient and proper to insure against overlapping, the witness replied:]

We have the agencies to do it now * * * but they have not been in existence very long, and their agenda today is badly crowded.

I mean the number of things they have to look at is so large that ways will have to be found, I believe, to try to do things more systematically and have less coming to a given committee. It is just a crowded schedule.

(p. 824)

Cooperation in decisions relative to Federal support of R. & D. (Bailey)

My last major point is that the various participants in the difficult decisions to be required in the future must find some way or ways to achieve a greater degree of cooperation and mutual confidence.

During the period of rapid growth of our research and development since World War II many of our decisions have been based on immediate needs or at the very best, short-term objectives. The present widespread concern, of which your investigation is just one manifestation, is evidence that we must base more of our decisions on other criteria. Many difficult decisions will be required as we define more clearly the long-range objectives and goals for the Nation, for the respective disciplines, for the Federal agencies, and for the universities—individually and collectively.

We commend your committee for the contribution you are making in providing a clearer picture of our present position and in establishing guides for our future course.

(p. 876)

Coordination and review of Federal research programs (Peyton)

A reexamination of present methods of coordinating and reviewing various research programs of the Federal Government is important and timely. We would, however, caution against attempts to establish an unwieldy and cumbersome superstructure or centralized agency to manage research and development.

The chamber suggests that the select committee concentrate its investigation on achieving better means to coordinate planning and communication and to improve existing systems.

(pp. 1033–1034)

Coordination of Federal research (Smith)

It is generally agreed that Federal research activities are uncoordinated both in planning and in operation. Agency activities are not related to one another, and they are not related to the Nation's overall research effort.

There should be proper coordination of research activities within the Federal Government to keep to a minimum unnecessary duplication of research and to minimize support of unnecessary projects.

(pp. 1039, 1040)

Coordination of Government research programs (Heald)

There is not enough coordination by the Government in the execution of the research programs of its various agencies or in communicating the results of research programs. More than just budgetary scrutiny is needed.

Coordination is needed to prevent the Government from competing against itself for the same services, thus spiraling the costs of research and delaying progress in the projects deprived of necessary personnel.

(pp. 387, 402)

Coordination of Government-wide R. & D. program and policy (Haworth)

The several administrative mechanisms [which Haworth had described in his testimony] perform a coordinating function, although they do not direct the departments and agencies. Through these mechanisms the people in the White House have a very good idea of what is going on in the Government, guarding against undue duplication and discovering gaps.

Leaving the work itself and its close direction in individual agencies is "a great advantage," because it is carried out by those which "know the requirements for the missions, which are best able to judge how to go about the work, who can put it in competition with other facets of their work," while the various mechanisms furnish coordination. "I think it is much better than to try to have it centralized * * *."

The complexity of science and technology * * * makes it increasingly necessary to have continuous coordination. The Federal Government's programs are no exception. In the first place, one is always confronted by the limitations of manpower, of facilities, and of fiscal resources. Secondly, one has to guard against fragmented research efforts where pooled resources would accomplish much more than merely the sum of the individual items. Thirdly, many scientific activities transcend the responsibility or interests of a single agency's mission. Then, too, one must safeguard against any unwarranted duplications or important omissions resulting from peculiarities of Government organization or of agency jurisdiction. Finally, the increasing knowledge of science and technology means that problems are never completely resolved, but must continuously be looked at from new vantage points.

(pp. 14–15, 29, 46)

Coordination of research (Brown)

Better intergovernmental coordination is needed when two or more Government agencies are sponsoring developments in the same area so that each can inform the other of its activities. An intergovernmental policing agency or coordinating agency is needed.

Coordination is difficult because research is so fragmented.

In the area of large developments, in the million- or billion-dollar range, it is inevitable that there is going to be intergovernmental coordination, even if it is imperfect coordination. In smaller projects, coordination is less certain, less complete, and much less good, although it still tends to happen. Intergovernmental cooperation is perhaps less needed in research than in large developments because smaller sums of money are involved.

(pp. 173–174, 179)

Coordination of research (Ewalt)

There should be more effort at the national level for supporting conferences concerned with the status of research in various areas and formulating statements of needs for research. The conferences could be supported by national professional associations or academies, and this should include support of international conferences.

Coordination of research also might be achieved through a profession's official organization, or through arrangement for coordination at the university level. The National Institutes of Health could have the department chairman sign applications for research and explain how the proposed research fits into the department's overall program; this would keep the research effort related to the teaching program.

(pp. 366, 370)

Coordination of research effort among Government agencies (Seaborg)

[After a review of coordination of R. & D. effort within the Atomic Energy Commission and among other Government agencies, the witness said:]

*** * * that the administrators of research and development in the Federal Government keep well aware of each other's programs, problems, and plans, and form a gratifyingly well-informed community. Nevertheless, this matter of coordination is such a vital responsibility of ours that we are continually striving to improve our mechanisms and practices.**

(pp. 69–70)

Coordination of research programs (Denney)

An area deserving consideration is the effective coordination between research programs in widely separated agencies. Coordination in the physical and life sciences has been better than in the social sciences, so the latter may learn something from the committee's work. The committee may wish to study the applicability to the social sciences of coordination and information-handling experience in the physical and life sciences.

(*a*) *Dissemination of research products*

I wonder how much of the total Government-sponsored research output in this field is being neglected by potential users simply because its existence is not more widely known. I wish that we in the State Department had better ways of taking advantage of other agency research programs in order that we could get more direct benefit from studies which parallel our interests.

The External Research Staff of the Bureau of Intelligence and Research in State is a little-known but effective step in the right direction.

(*b*) *Coordination on contracts*

Improvements are necessary in the reporting of contracts let. The quarterly publication, "Government-Sponsored Research on Foreign Areas," does not include research on international affairs sponsored by such major domestic agencies as Agriculture, Health, Commerce. These programs have not been registered and reported by State because of lack of funds.

There seems to be general agreement that some sort of interdepartmental mechanism is needed for better coordination on planning of research contracts. Representatives of other agencies have suggested that the State Department take the lead in establishing an interdepartmental coordination committee for contract research on foreign areas, cross-cultural studies, and international affairs studies, and exploratory discussions on this idea are now being held.

(pp. 191, 192, 196)

Correlation of Government research programs (Bush)

There is a lack of correlation among the various programs and agencies, and a lack of overall direction. This has an adverse effect upon efficiency and economy in the conduct of our research activities in Government.

(p. 468)

Interagency coordination in the Department of HEW (Jones of HEW)

There is, presently, effective coordination among diverse research programs administered by HEW, to prevent unnecessary duplication and waste, but improvement would be possible.

However, I might say we are never quite satisfied that we can't do this kind of thing better. We are shorthanded at the policy level in the Department of Health, Education, and Welfare. We need additional help there.

The Secretary and the President have asked for additional help. It has not yet been forthcoming. We are hopeful that we can have the policy echelon of the Department strengthened in order that we may do these coordinating jobs better.

(pp. 550–551)

D. Dangers of Excessive Coordination

Coordination of research (Calkins)

If the committee should find reasons for some greater coordination of development effort among different agencies seeking common or related objectives, it is to be hoped that it will be conscious of the parallel dangers of unnecessary coordination and of the delays and red tape that so often accompany such coordination between departments and agencies.

As for research, better communication is desirable, but the diverse and individual approaches to research make coordination extremely difficult. Furthermore, each agency has different interests and objectives for the research it sponsors. Highly centralized research is not desirable. Nor is a centralized control over research funds. It is in the national interest that the research establishment have alternative sources of support.

(p. 914)

E. Coordination of Multiagency R. & D. Programs

Areas of overlap (Halaby)

The committee should look at the interstices, the areas between agencies in research and development, because it is in those that often the overlap and duplication is found. The principal areas of overlap

with the work of the Federal Aviation Agency are the Department of Defense and the National Aeronautics and Space Administration.

a. Aeronautical and electronic work

FAA, NASA, and DOD all work in this area, and

we believe through the law and through the practice we have eliminated unnecessary duplicating work. But no man can sit here and guarantee that, in agencies as large and as complicated as these three agencies.

b. Weather research and development

FAA does some, the Weather Bureau does most of it, and the Department of Defense does some. For years several agencies have been working in this area.

And I don't believe any one of the last three or four administrations have quite worked it out so that we are getting the most weather research and development for our money.

(pp. 130–131, 137, 148–149)

Coordination and duplication of research (Foster)

In a research program of such breadth as that of the Arms Control and Disarmament Agency, there is a potential for duplication, both within the Agency, and between the Agency and other agencies with related research responsibilities and with an interest in all Government-sponsored research in this area. The Agency has gone to considerable effort to minimize duplication. [The Agency's procedures are described in some detail.]

* * * I believe that our coordination efforts are working well. I know of no instance where there is significant duplicative effort. Naturally, we are constantly trying to improve our procedures. At the moment we are working with other agencies to coordinate objectives, as well as actual research. * * * We also plan formalized procedures to make certain that the results of research are known and utilized by all agencies that might have an interest or need.

(pp. 774–775)

Coordination of Federal R. & D. programs (Hollomon)

When R. & D. programs are formulated for various purposes they frequently have certain elements which are closely related. Programs having to do with the atmosphere furnish an example. These programs are found in at least six different departments and agencies.

Obviously, then, there is a problem of coordinating and relating the activities that have to do with atmospheric sciences, to determine whether there is overlapping, whether the program is meeting the objectives effectively, whether the costs are justified in terms of the benefits, whether the program is of sufficiently high quality.

These tasks are presently performed by the Interagency Committee for Atmospheric Sciences which

is undertaking special analyses to determine the reasons for the atmospheric science research, its extent, its degree, whether it is effective, whether they are overlapping and whether new institutions are required.

(pp. 293, 297)

Coordination of Federal R. & D. program through the budget (Wenk)

At the present time we have no way of dealing with the science and technology budget as a whole. There are two reasons for this:

In the first place, I do not think we feel we are wise enough to do this. But, in the second instance, the purposes of the conduct of research and development are so varied that at least as far as the development side is concerned the sponsorship * * * is linked much more closely to the direct purpose than it is * * * vertically * * * to defense or to public health or to transportation or to some other particular end application than it is with regard to the relationship horizontally as between the different components.

We do, for accounting purposes in order to understand the total research and development activity, in order to understand the demand for manpower, which is common, to understand the fraction of this total that is devoted to basic research versus applied research and development, for these purposes, we do combine all of the research and development activities that we can, so as to identify in one package which we call, and which is published, incidentally, by the Science Foundation and called "Federal Funds for Science."

[Question: But you do not make any effort to stay within an overall limitation?]

No, sir; we do not.

(p. 251)

Coordination of research (Staats)

There is need for better coordination among department and agencies interested in the same area of research. In the past few years we have made headway on this problem. Joint working groups made up of representatives from agencies working in the same area have been set up under the Federal Council for Science and Technology (for example, oceanography and atmospheric research). Similar procedures could be applied in other areas. Examiners on the Bureau of the Budget staff work with the Federal Council committees to facilitate a coordinated review within the Bureau of particular fields on a Government-wide basis. In some cases responsibilities for a particular field are clarified by vesting leadership in one department or agency, without encroaching on the operational responsibilities of the respective mission-oriented agencies.

The Office of Science and Technology in the Executive Office of the President is—

a flexible, selective mechanism for dealing with policy problems arising out of research and development, and for providing a framework of coordination which stops short of interference with the immediate responsibilities of the department and agency heads.

* * * * * * *

We feel that this is all the topside machinery we can effectively employ in clarifying Government-wide research and development objectives, identifying priorities, and improving interagency coordination. * * * For the immediate future, at least, we do not see a need for additional coordinating machinery in the executive branch. * * *

(pp. 566–567, 592)

Duplication and coordination of research (Calhoun)

* * * We [Department of the Interior] operate really on three levels. Each of the staff members keeps close contact with counterparts in other agencies. And I believe that at the staff level these people are very much aware of what is going on in some other agency or department.

In the second place, all of our research will be reported by January 1964 to Science Information Exchange * * * which places our research projects on record

and other research projects on record, so that your research people can take advantage of this.

* * * since I have been in the Department * * * so far as I have been able to examine the question, I have not found anything which I would call unwarranted duplication.

* * * within these agencies [the Bureau of the Budget, the Office of Science and Technology, and the Federal Council of Science and Technology] and their mechanisms there does exist all that is needed in order to achieve this coordination and cooperation. I can think of nothing that cannot be handled within this structure.

(pp. 123–124)

Duplication in Government research projects (von Braun)

Many recent articles have called attention to "X" number of Government agencies conducting research in some scientific field—such as meteorology. Although the interest of each agency can be explained on the basis of the primary missions of these agencies, the articles fail to do this and

* * * the innuendo creeps in that the Government is busily duplicating its research projects at the expense of the taxpayers. To the discerning reader, such as members of this committee, such a statement is immediately put into its proper focus. But to the less informed public, such a statement, plus the innuendo, unfortunately may stand as fact.

But today the nature and the complexity of our great scientific projects require contributions from all parts of the scientific community.

These facts of life illustrate the point that the uncomplicated world of the solitary scientist * * * is a thing of the past. * * * Today the interdisciplinary approach is a must—it cannot be fragmented. * * * technology gets more sophisticated. The engineer, like the scientist, can no longer work alone. He must have an interdisciplinary capacity of his own.

Thus the legitimate interest of more than one Government agency in the same research field is apparent. * * * this condition will continue.

* * * I want to make clear that I am not advocating unnecessary duplication of research projects. Nor am I recommending that any agency with a superproject to manage put blinders on and proceed merrily on its way, totally oblivious to the research efforts of others.

"Unnecessary duplication" does not preclude "desirable duplication" in those instances where confirmation of results of a research study is required. Existence of duplication does not automatically constitute a case of waste and mismanagement.

(pp. 516–518, 522–523, 525–526, 530–532)

The establishment of national programs in various scientific areas (Kistiakowsky)

Such a national program as the one for the study of oceanography is

* * * a valuable step forward and it is my hope that such programs will extend to many other scientific areas. These programs insure that several agencies involved in each area act in a coordinated fashion, eliminating duplication, filling voids and still preserving adequate agency initiative to insure that good scientific bets will not be missed. From the congressional point of view such programs should also be encouraged, since they will provide Congress with a relatively concise source from which one can better evaluate what the Government as a whole is aiming to achieve in a given technical area, rather than dealing with bits and pieces in the budgets of different agencies.

(p. 611)

Executive coordination of Federal agencies' R. & D. programs (Wenk)

[Considerable testimony was devoted to a discussion of the philosophy, the method of operation, and the objectives of the Federal Council for Science and Technology within the Executive Office of the President, as a mechanism for planning and coordinating Governmentwide R. & D. programs and policies.]

To date the criteria for selecting multiagency programs to be reviewed and coordinated include the following:

(*a*) Programs deemed to be national programs;

(*b*) Fields of research whose growth and stimulation are deemed urgently needed in the national interest;

(*c*) Multiagency performance of programs, whose components are undertaken within the statutory authority of a number of different agencies; and

(*d*) Specific Presidential requests to develop national programs.

The Federal Council for Science and Technology is a relatively new experiment to meet the problems of interagency coordination. It is having a good record of achievement as a pioneering tool in science management.

[Neither the Council nor any] single organizational device can be a panacea for interagency ailments. * * *

The Council was proposed as an experiment to meet growing problems of coordination, but in no way is it expected to encompass all activities in the domain of science and technology.

We must remember that the events and circumstances that surround the birth and growth of our individual departments may not foster any great incentive for cooperation. * * *

(pp. 236, 250)

Government advisory committees as coordinating devices (Schairer)

* * * These committees serve as a forum for the communication of, discussion of, and coordination of Government research and development programs in the areas of the particular competencies of the members of the committees.

Conflict of interest has never been a problem in properly run committees. I believe you will find on investigation that these committees are the most powerful and effective means possible for coordinating the Nation's research both within the Government and with outside agencies. These committees prevent unknowing duplication and materially raise the sights of all research groups in the country.

I recommend that your committee become aware of the nature of these advisory committee activities and satisfy yourself that all Government agencies have an adequate activity of this type.

(pp. 1036–1037)

Governmentwide R. & D. programs adopted or endorsed by the Federal Council for Science and Technology (Wenk)

Even when a program has been identified or developed as a national program, reviewed, evaluated, and coordinated, dislocations are likely to occur primarily because of the following problems:

(a) The most serious of these is the preservation of budget integrity both within the executive branch and within the Congress where different committees review the program on an agency-by-agency basis.

(b) The stimulation of new activities essential to completing the balance of a broad program but new activities which do not fall within the jurisdiction or historic interest of any single agency.

(c) There is a serious problem involved in staffing the various committees of the Council. Additional administrative staff for the Council is needed largely because of intensified public interest in its work.

(pp. 239–240, 249–250)

"Governmentwide" or "national" programs as the basis for future action (Wiesner)

There is not enough assurance that a multiagency (often called a governmentwide or national) program based on a balanced plan worked out in the Executive, will become the basis for future action. Reasonably successful efforts (for example, the 10-year program in oceanography) have been made recently in developing agency support for such programs, worked out by the Federal Council.

Problems facing these planned and balanced programs stem from such factors as:

(1) new research which indicates new opportunities and a need for revision of the plan;

(2) the annual budget process as it affects interagency programs; and

(3) the review of pieces of a coordinated program by more than one congressional committee, without the overall perspective developed in the original planning.

* * * the committees in Congress who have responsibility for these agencies haven't the same determination to hold a national program together that the Space Committee has, for example.

I think we are in a better position to manage the executive part of the oceanography or any interagency program than we are the congressional part.

I think that what we must be doing is working out between the executive branch and the Congress the most appropriate way to keep these vital programs going in the way both of us desire.

* * * At this time I should not venture either to diagnose or to propose solutions to the problems that the Congress may perceive in its own procedures for dealing with scientific matters, although I emphasize that your interest in the problems of receiving and utilizing scientific and technical advice and information is familiar to those who have observed and participated in the long process of evolution of Executive machinery for exactly these purposes. The number and extent of programs involving multiagency participation can be expected to grow if the agencies are to realize the full potential of science and technology for the fulfillment of their missions without unnecessary duplication. * * * In the interest of economy, in the use of funds and manpower, these intrinsic benefits should be recognized through all our Governmental procedures, congressional as well as Executive.

(pp. 262, 265, 274–277)

Nongovernmental professional associations as coordinating devices (Schairer)

* * * These professional societies offer excellent forums for the exchange of information and communications concerning what is going on in the fields of research and development. Although these professional societies need very little direct Government support, they operate best when the Government recognizes the great importance of their activities and cooperates in the accomplishment of their programs.

(p. 1037)

V. THE UNIVERSITIES AND EDUCATION

A. Relationships With Federal Government

Basic differences between Federal Government and universities (Rose)

There are problems that arise because the Federal Government and the universities differ as to how the Nation's research needs can be met.

Federal agencies working with the universities surely must present a discordant chorus of opinion to Congress; the universities also offer a multitude of opinions. The best cried needs are not necessarily the most important ones. The apparent lack of clear national policy vis-a-vis either universities or research compounds Congress' problem.

The Federal Government is organized to support mission-oriented research, not to support universities.

A university is not organized to administer Government funds for research, to identify and pursue its research administration problems, to exert leadership in the formulation of national policy on research administration.

(p. 791)

A council of advisers on education (Kerr)

A council of advisers on education would provide an overall view of education as no single agency can do it. This could present a more coordinated view to the Federal Government.

Such a council could draw up a manpower budget indicating supply and demand of skills depending upon higher education. This would be nationally useful as an indicator of human resources.

(p. 1026)

Dependence of national preeminence upon quality of education (Stiles)

* * * It is futile to spend large amounts to discover scientific knowledge and to produce technical equipment for defense and peacetime industrial production while failing to develop the human resources essential to its use. Manpower supply requires more than the few highly gifted and specialized scientists and engineers—vital as such are. It involves the total educational development of the wide ranges of human talent that are necessary to implement ideas, manage operations, operate equipment, supply services and to make the citizenship decisions that mean the difference between success and failure. Education is the instrument by which skilled manpower is produced. The Nation dare not permit its schools to grow obsolete or to function below proper quality levels. Advances in scientific knowledge and space technology, particularly, will be both retarded and poorly implemented if our program of education is not brought and kept abreast of the intellectual requirements of the times. Quality in education, as in other fields, is directly related to the investment made in educational research and development.

(p. 1060)

Federal Government-university relationship (Seaborg)

So far as basic research is concerned, the Federal Government-university relationship is a partnership—"each necessary and neither one sufficient."

The functions of universities are of absolutely critical importance to the national welfare, and the Federal Government will be a major factor in determining whether the quantity and quality of basic research and graduate education in the United States will be adequate or inadequate.

The standard of excellence of our top-rate universities must be maintained and extended to more institutions.

Equally important is the encouragement of an increase in the number of universities in which first-rate basic research and graduate teaching go forward together.

Universities must insure that their own standards of freedom and excellence are maintained in a period of growing connection with the Federal Government.

Better relationships between the Government and the university, directed toward strengthening the university as a whole, is in the Government's best interest.

(pp. 67–68, 70)

National research policies as related to universities (Rose)

It is suggested that the committee lead in determining national policies concerning (*a*) universities in general, (*b*) research in general, and (*c*) universities in research in particular.

In this determination agency-mission-related research and research directed to national goals will have to be considered to accommodate and facilitate Federal research.

(p. 792)

Role of the Federal Government in solution of education problems (Kerr)

In solving problems of U.S. education, the Federal Government "need not and cannot do everything."

(p. 1024)

Use of the universities as instruments of national R. & D. policy (Harrar)

The universities constitute the greatest pool of brains and ability in existence and—

their collective accomplishments in research and in the training of scholars and scientists represent one of our most important national resources and one of incalculable value to society.

For this reason their use as instruments for national benefit should be continued. The effort might be two pronged.

* * * One direction would be freely to take advantage of the best the university community has to offer in the service of society in ways which would make the university a better training center and a more powerful research entity. The other prong would be directed toward the reinforcement of institutions not so far advanced, with the purpose of broadening the base of high-quality training and research. This would greatly help the institutions, their staffs and student bodies and would add new resources to the scientific and educational community in the service of the Nation.

In thus reinforcing the educational system the universities should be free to develop their programs in accord with their own judgments. Also, the art of teaching must be given greater recognition and never become subservient to the practice of research.

(p. 1017)

B. Benefits Resulting From Federal Research Support

Arguments supporting Government support of scientific and engineering research in universities (Steimke)

Government support of research and graduate fellowships and traineeships is desirable, is in the best national interest, and is a necessary and rewarding investment of Federal funds. It contributes to the Nation's pool of highly trained engineers and scientists and to the national research effort.

It is fitting and appropriate that the Federal Government support research activities because (1) only the Federal Government is capable of taking the long-range view which best serves the national interest for the future; (2) research leads to the production of suitably trained manpower; (3) research leads to new knowledge, which has been the timeless responsibility of institutions of higher education; and (4) Government-sponsored programs of scientific and engineering research in universities are a real bargain to the Government, since graduate

students, working in these programs for a nominal salary, are professional people selected from the top of undergraduate classes and capable of making professional contributions to the projects on which they work.

(pp. 613–614)

Benefits to the University of Alabama from Federal research funds (Rose)

The three major areas of benefit, discussed below, are apart from the usefulness of the results to the agency supporting the research, or the contribution of the research to general knowledge. It is clear that the benefits resulting from availability of these funds definitely outweigh the problems they create.

(1) Divisions within the university carrying out federally sponsored research have been greatly strengthened in terms of staff, numbers and quality of graduate assistants, and equipment.

(2) Our graduate research and teaching programs have been able to produce more and better-trained graduate students.

(3) The climate that has been created by the Federal-supported research programs has made possible an exchange of information and visits and other leading scientists in relevant fields.

(pp. 788–789)

Effect on universities as result of Federal research expenditures (DuBridge)

On this question various assertions have been made.

Thus, some say, higher education has been ruined because our campuses have become military or industrial research centers.

This, I insist, is false. Many universities are, of course, performing valuable services for national defense—but mostly this is being done in off-campus centers which have in no serious way degraded the scholarly atmosphere or the educational excellence of the campus itself.

Quite the contrary—by building up campus centers of basic research, the educational excellence of our fine universities has been improved. Leading scholars no longer need to go to industrial laboratories to get adequate salaries and research facilities. They can get them on the campus—and help teach a new generation of scholars besides.

(pp. 306, 310)

Effects of Federal support of research at University of New Hampshire (McConnell)

Limited to State funds and tuition, and without Federal support, this university could not have reached its present level of excellence and competence. Beginning with the Government's support of research in the life sciences areas of the College of Agriculture in the 1890's (Hatch Act), support in the physical sciences and engineering areas from various Federal departments and agencies' programs has been added. This financial support has made it possible to undertake previously impossible tasks of significant research and education. Some of the results have brought national and international recognition, which in turn has attracted highly competent faculty who have developed and trained young scientists and engineers to perform the R. & D. of the future. Curricula have been expanded and

departments have grown as the result of federally funded operations. For example, in 1955 the physics department was only an undergraduate operation; in 1963, it offers the Ph. D. with 25 graduate students enrolled.

The general impact of the past and continuing research support programs cannot be measured at the time of the effort.

(pp. 858–859, 863, 868, 869–870)

Justification for Federal involvement in university research (Fawcett)

It must be clear to all that there would be no substantial research effort in American universities today without Federal support. This is true if for no other reason than the cost of research in many fields today. This applies with special force to basic research, the type for which the universities have unique competence but also the type for which there is seldom any immediate commercial application and, consequently, any commercial or industrial sponsors.

Furthermore, our culture, our civilization, our economy are today national in scope and orientation. Our most important economic units extend across the country. Our future sources of talent are likewise dispersed across the Nation. Therefore,

We must think in terms of national interest and national involvement when we consider the need for a substantial research program.

There is, further, no other source of funds that is adequate to the magnitude of research effort that is vital to the maintenance of a highly complex, highly industrialized democracy. * * * Only Federal assistance has made university research on a significant scale possible; and if this assistance is reduced or withdrawn, the research activity will of necessity be materially reduced. There simply will be no other choice for the universities.

The importance of this fact cannot be minimized. It is basic research—university research, if you will—that has given this country its position of world leadership, and without university research, that position cannot be maintained. * * *

The record of accomplishment brought about through university research confirms the above statement—as, for example, in the virtual elimination of hunger in one part of the world; the new and almost unlimited source of energy from the splitting of the atom; cures and preventions of most dreaded ills, and others. Most of these accomplishments came about through basic research carried out in university laboratories assisted by Federal funds.

(pp. 997–998)

Measuring recent research accomplishment supported by Government funds (Bailey)

An extensive catalog could be prepared of the tangible benefits that have accrued as the result of R. & D. activities supported by the Government during the past two decades. In addition to new knowledge and new ways to use existing knowledge, the universities consider the development of new scholars and research workers to be of equal, or sometimes greater, value.

At the graduate level, research and instructional programs of excellence are inseparable. We have long recognized this in the area of basic research and it is also true of much applied research and some of the development work now being done in our universities.

Graduate students who have participated in contract research programs are proving to be of greater value to industry and Government than those who have not had opportunities for development work.

We are aware that overemphasis on research can ultimately detract from the overall instructional program. It is in this area that the universities have the responsibility to determine the proper balance for our respective institutions.

(pp. 873–874)

Relative advantages to the Federal Government and to the universities of federally financed research in the universities (Scheps)

* * * substantial benefits come to the universities through Federally sponsored research. * * *

We believe, however, that the advantages are even more important to the Federal Government because research and trained manpower are acquired at far lower cost than could otherwise be possible. [Information on relative costs for the Federal Government, industry, and the universities was cited.]

* * * * * * *

The partnership between the Government and the universities in the conduct of this research program has been a productive one. We believe that the partnership should be expanded. Such a partnership:

(1) Provides the best arrangement for encouraging basic research at the lowest possible cost.

(2) Is the most efficient method of increasing the number and quality of scientists to meet the ever-increasing Federal need.

(3) Enables larger numbers of institutions to improve their science curriculums and, through research, to stimulate the emergence of new ideas, new techniques, and new concepts.

(4) Places at the Nation's disposal a pool of trained personnel to solve problems that may become urgent in periods of national emergency.

(pp. 918, 920–922)

Support of nonscience fields in universities (Wiesner)

* * * we are coming to the situation where we need to face how to rationalize these vast expenditures that go into the universities so that there is a more uniform treatment of schools.

Practically, no modern university could exist in its present state without the support it now receives from the Federal Government in the scientific fields, and I am sure that this has an impact on the nonscience fields. We don't help support the nonscientific programs in universities that are in just as much trouble, so this breeds other distortions. The administration education bills have tried to create some things which would try to redress this balance, and I think the Congress is moving forward with many of them. * * *

(pp. 288–289)

C. Adverse Effects of Federal Research Support

Diversion of universities from their primary task of education (Bush)

The extensive reliance by the armed services since World War II on universities "to manage great programs of research and development, involving secrecy, and often calling for business judgment" is a "strange" and "dangerous" development. Some of this difficulty has been avoided by creation of independent nonprofit organizations. The proper business of universities is education and this concept should be adhered to.

Every research program placed in a university should be so ordered that its product is not only new knowledge but skilled educated men.

(p. 463)

Effect of Federal research grants, contracts, and scholarships on universities (Peyton)

Another serious problem * * * is the impact of Federal research grants, contracts, and scholarships on colleges and universities. Studies to date * * * indicate that highly questionable priorities are being given to placement of student scholarship funds, faculty duties and salaries, and construction of facilities as a result of large increases in Federal research expenditures. Federal programs are in competition, not only with each other but also with the private sector of the economy, for talent, the supply of which is not inexhaustible. Related to this seems to be the impact of federally financed research on competition between the sciences and the humanities for youthful brainpower. This would involve consideration of whether or not an imbalance is developing which might lead to permanent distortion in the faculty, curriculums, and career planning of students of our colleges and universities.

(p. 1034)

The effects of Federal research aid on the finances and administration of universities (Kerr)

Federal support has been of great benefit to universities but it has not been without its costs in money and effort.

Overhead allowances vary greatly from agency to agency but seldom cover all indirect costs as well as the direct costs of the sponsored research.

Matching construction grants often force a university to change its building priorities to secure the Federal money, and thus the Federal area of interest tends to be favored at the institution. This is a further cause of imbalance.

Great new administrative burdens have been added to the faculty, department heads, deans and presidents. New administrative officials—the contracting officer and the research project manager—have had to be created.

(p. 1023)

Effects of Federal research aid on undergraduate education (Kerr)

Federal research support has strengthened graduate education because graduate work involves research. Undergraduate education, however, has suffered in the process.

Teaching loads and student contact hours are reduced. Faculty members are more frequently on leave or temporarily away from the campus. A greater amount of the teaching falls to teachers who are not members of the "regular" faculty. The best graduate students prefer fellowships and research assistantships to teaching assistantships. Postdoctoral fellows who might fill the gap usually do not teach. Average class size has been increasing.

The problem was growing in the universities before they received Federal funds, but this assistance has intensified it. A big problem of the "Federal grant" universities is that a superior faculty results in an inferior concern for undergraduate teaching.

(pp. 1022–1023)

The grant-contract-fellowship mechanism of distributing Federal research assistance to the universities (Fawcett)

The discussion of this subject applies to basic research—"that type for which the universities have unique competence and for which they provide unique conditions." This type constitutes only about one-tenth of Federal expenditures for R. & D. A large percentage of this assistance is based on a purchase-of-service and an agency-to-individual contract mechanism that "served admirably the urgent applied-research needs of World War II."

But, even though the philosophy and mechanism have not changed materially, both the magnitude of the effort and the type of research needed have changed. The growth of the magnitude of the effort is well known and advertised. The significance of the shift in the type of research required, however, has not received sufficient attention.

During World War II we used our stock of basic knowledge, making little effort to replenish it. Since the war we have redirected part of our effort to basic research. The establishment of the National Science Foundation and the National Institutes of Health are examples of this new effort. This is the type of research for which the universities have unique competence.

The purchase-of-service, agency-to-individual mechanism does not always serve well this type of research. It is difficult—sometimes impossible—to organize a long-range exploration of basic phenomena in a particular area within neatly packaged 1-, 2-, or 3-year projects, each with its own unit justification. The mechanism tends to drive a wedge between the instructional and the research functions of the university, to the eventual detriment of both. It discriminates in favor of the established scientist and against the newcomer. It contributes to the concentration of research competence within a few institutions, making it difficult for others to maintain and develop the resources needed in order that their ability to serve the Nation might be strengthened. The submission of proposals, the review-board mechanism, and the institution-to-agency liaison activity that are integral parts of the system are expensive in terms of the large amounts of money and the great number of individual projects now involved. Most important of all, the mechanism largely bypasses the institution itself and, in doing so, tends to deny to the institution the fiscal and administrative authority it needs to discharge its responsibilities for the programs.

Even though the approval of the institution must be attached to each proposal and each contract or grant, this approval amounts to little more than veto power, which if exercised, may result in the research worker taking his project with him to another university. Because of this, the system erodes the ability of the institution to direct its own development in research, especially in the less affluent, less prestigious institutions. Further, it makes it more difficult for the university's financial officer to exercise careful fiscal supervision over the project. In this situation, the university itself tends to be forced into a middle-management liaison role, providing career stability for prospective grantees and lending the prestige of the institution to the proposal.

(pp. 998-999)

Imbalance resulting from Federal support to research at the University of New Hampshire (McConnell)

A university must grow and develop in a balanced way. In the decade of the fifties, primarily because of Federal support, the master's degrees awarded nationally in the sciences increased by about 28 percent and doctoral degrees by 33 percent. However, during the same period, the number of students enrolled for and obtaining the bachelor of science degree in the sciences (from whom future ad-

vanced degree candidates are drawn) decreased by 9 percent. This illustrates the necessity for a university to achieve a vertical balance, in the sense that a reasonable proportion of its efforts and numbers be distributed from the undergraduates, through the graduate student group, to the postdoctoral fellows and faculty research programs, in order that there be a downward movement of knowledge and enthusiasm which permeates the total academic scene. This vertical balance has been partially restored by the National Science Foundation programs supporting the highly talented undergraduate.

These superior undergraduate students mentioned above are frequently selected in graduate school as project assistants under a research grant or contract, or they receive the excellent fellowships available from Government agencies. Such opportunities are highly desirable from the student's viewpoint, but they also have the effect of leaving the less able graduate students to fill the salaried teaching assistant positions. Perhaps some equalizing of salaries between research and teaching assistants would create a better distribution of qualified people.

More assistance for young faculty members needs consideration. A young Ph. D. may decide to teach while pursuing research he started in his late undergraduate years. Unless he is in a university department where the senior members hold grants or contracts in the areas of his interest, he must survive as best he can for about a 5-year period until he can earn some reputation as a researcher.

The result of research support in the science and engineering has accelerated improvement of the quality of science education at all levels, but such improvement has not been achieved in the social sciences and humanities. The result has been a lopsided educational offering from which the student must choose.

There is imbalance in the university physical plant. Research proposals are enthusiastically prepared by faculty and administration without thoroughly examining in advance where the research will be conducted, as well as how to fit it into the total academic program. Overindulgence in sponsored research may bring conversion of classrooms for research use, cramping of course schedules, and reduction in growth space for other discipline. On-going research may create serious physical space needs on a campus, as it has at the University of New Hampshire.

*** * * we have reached the state in a few of our disciplines, and are rapidly reaching it in others, where we must curtail further expansion of our research efforts, even though we have the faculty and graduate student capability to do more, until such time as we can augment our physical plant.**

(pp. 859–861)

Imbalances in the university produced by large amounts of money (Rose)

Imbalances, produced by the availability of large sums of money to universities, occur between the natural sciences and the humanities and social sciences, among the various sciences, between branches within a single science, between pure and applied science, and between research and other duties of a professor.

Solutions to the imbalances depend on decisions at the national level, although the university can work on the problems.

Most States, including Alabama, are already overburdened simply to meet the present, inadequate educational program. Hence, there is no great hope for balancing funds other than those provided by the Federal Government.

(pp. 789–790)

Impact of Federal regulations and procedures on universities (Rose)

Federally-sponsored research brought burdens to academic and business administrators at the University of Alabama because new problems were produced for which adequate internal policies were late in being evolved. Understanding the many Federal regulations and keeping current with them was a serious problem.

Administrative relationships with faculty have been strained at times because some academic administrators looked upon the research program as a "bothersome supplement" to their routine responsibilities and they have felt their freedom was impeded by research policies and procedures. Recent requirements of some agencies for monthly and quarterly "effort reporting" have complicated the situation. Faculty members have not always understood and sympathized with the desire of administrators to obtain full-cost reimbursements for research. Not comprehending the necessity of the university's seeking reimbursement for indirect costs, the professor-researcher has objected to having a portion of his salary allocated to a research agreement.

(pp. 789–790)

Impact of Federal research programs on universities (Wilson)

The general impact of research programs on universities has on the whole been highly beneficial, and "it is this positive note which I would stress."

It is my hope, however, that during the course of your study, you will also consider some of the problems, for they are real.

High on the list of problems is the one concerning the strain that sponsored research places on the unrestricted funds of universities. This strain derives from the difference between what the Government allows universities for indirect costs and their actual indirect costs, which difference amounts to about $35 million a year. While small when compared with the Government's total outlay on research, it is a substantial—even large—sum in terms of university resources.

* * * I do not believe that the Government can or should subsidize all fields of learning which universities are committed to support. But I do believe that it should be concerned with the imbalance that now exists among the disciplines. To the extent that the universities' free funds must be channeled off into the support of Government research, to that same extent the imbalance between science on the one hand and social science, the humanities, and the arts on the other will grow worse.

* * * The role of the Government in what is obviously a growing partnership for the public good is on the one hand to provide support for those activities that are determined to be in the Government's interest and on the other to provide that support in a way which strengthens rather than weakens one of our most valuable national assets, the American system of higher education.

(pp. 510–512)

Impact of Government-supported research on higher education (Heald)

Government research has had a tremendous impact on higher education. The effects have been beneficial in many ways. In other ways, they have produced some pressures and distortions that give some educators and others considerable concern.

Among the positive results for universities are (1) vastly increased capacity to pursue the discovery of knowledge; (2) enhancement of the main mission of the university—the transmission of knowledge; (3) possibility of retaining on their staffs highly competent scientists and teachers; and (4) provision of better equipment and laboratories than they could otherwise afford.

Under the heavy demands made on the universities by the Government, at the time of one of the most dynamic periods in American higher education, "higher education is strained to maintain an essential equilibrium" between the primary mission of the university and factors that tend to distract the universities unduly. The extramural demands of Government research (1) draw great numbers of faculty away from their primary mission of education and research; (2) also influence the content of education and the attitudes of researchers; and (3) even control graduate enrollments, favoring students in the fields of natural science and engineering in comparison with those in humanities and social sciences. The committee might consider whether Government-supported research, or support for problem-solving research, are in any degree impairing the universities' ability to train more and better personnel.

Problems which the committee might consider include:

Is research keeping too many faculty members away from the classroom too long? * * *

Is the concentration of Federal research funds in one group of universities disadvantaging the ability of other universities to serve well?

Particularly, are the undergraduate liberal colleges * * * handicapped? [Scientific personnel is drawn off elsewhere]

Is the concentration on some research fields leading to the neglect of others that in the near or distant future are likely to be as vital to the national interest as currently emphasized fields?

If the graduate student is, in effect, an employee of a specialized team working toward an applied-research objective, is he also receiving the broad and free scholarly experience that will enable him to cope with less specialized problems and with the philosophical and scientific principles underlying his own field?

Greater dispersion of Federal funds, rather than concentration at a few institutions, would help strengthen higher education nationwide. Direct Federal aid to education may help remedy the imbalance produced by grants and contracts under the Federal research program.

There is danger that research can become self defeating by weakening its educational base through deterioration of teaching.

(pp. 384–386, 401–402)

Nonuse of Government-financed research facilities in the universities (Steimke)

The Government should utilize a new 5-megawatt research reactor recently put into operation at Georgia Tech. This reactor was built at a cost of $4½ million, paid for mostly from State of Georgia funds,

but with a substantial investment by AEC and NSF. It is a unique facility in its capabilities and is designed for research in many areas, including basic studies of materials and medical research. Some Government agency should probably establish research programs centering around this reactor, but to date, in spite of vigorous efforts to secure such support, none has been forthcoming.

(p. 616)

Problems arising in connection with Federal expenditures for basic research in universities (DuBridge)

Now, I do not pretend that the Federal expenditures for basic research in universities have not given rise to difficulties. There have been some mistakes here and there in fiscal management. Some universities have had trouble in finding funds to build their nonscience departments at a rate comparable to the expansion of the science departments. There have been misunderstandings and disagreements as to allocation of faculty salaries and the calculation of proper overhead or indirect costs.

I insist that all of these problems and difficulties constitute but a minor blemish or difficulty on an otherwise healthy situation—and on an undeniably valuable national scientific effort.

Suggestions for curing these difficulties are:

(1) Universities should get together to discuss the problems and solve their own disagreements.

(2) The Government should adopt a more effective policy for paying the full costs of the basic research. If the universities must divert other funds to support science projects, the nonscience activities suffer further. It is unfortunate to impose an unrealistic figure like 20 percent as the indirect cost of research; the true costs are generally much higher and the payment of the extra costs by the universities weakens them. The total costs to all universities runs to many millions.

(3) Budget appropriations to such agencies as the National Science Foundation should be made more adequate. This would stabilize research programs, allow grants on a longer, more stable basis, give support to research institutions and individuals now not able to make their maximum contribution, and be an investment in the Nation's future.

(pp. 307, 311–312, 313–315)

University-Federal Government relationships in basic research programs (Long)

The procedures for awarding and supervising contracts and grants could be improved. For example:

(1) It is more efficient if the research grants are made in large units rather than small. This makes for efficiency in the purchase of equipment, in accounting procedures, and in the research operation itself.

(2) Continuity of research is an important contributor to increased efficiency of the research and in permitting universities to plan.

(3) Granting a modest amount of research support to a university, to award as it chooses, would enable the university to aid areas of research which are relatively neglected.

(4) Simplified accounting procedures by Federal agencies would reduce the cost of administering contracts and decrease thereby the administrative overhead. Accounting procedures used to apply to purchase of equipment are not necessarily appropriate to accounting for personnel costs.

(5) The present overhead cost allotments for research in universities (25 percent is typical of National Science Foundation and some other agencies) causes difficult financial problems for the universities, many of which now have to find other sources of aid for research. The current proposal to reduce this to 20 percent will seriously aggravate the problem.

I would not, however, like to close this discussion on a note of pessimism. The facts are that the cooperation between universities and the Federal Government for the conduct of the Nation's basic research has, in my judgment, been extraordinarily fruitful and effective. It has benefited both the universities and the Nation. I am confident that Federal support of basic research will continue and that the procedures for managing this support will become increasingly effective. The universities are as eager as the Federal Government to be sure that this research support is wisely used and that the research activities interact in the most favorable way with the teaching operations of the universities and with the overall economy and welfare of the country. I am confident that cooperation between the Federal agencies and the universities will continue to be excellent, and I see no problems which cannot and will not be solved.

(pp. 484–485)

D. Effects of Federal Research Support on the Educational Program

Assistance to undergraduate research and teaching (Dickey)

Advanced research cannot be better than the fundamental quality of undergraduate preparation. Increasing recognition should be given to encouragement of research activity in undergraduate teaching.

(p. 1076)

Distinction between research projects and projects to improve education (Kemeny)

It is impossible to draw a sharp line between the two types. The article entitled "Once the professor was a teacher," from the New York Times Magazine, June 2, 1963 (pp. 1070–1074) discusses the adverse effects upon the university's teaching function of the professor's work as a researcher or consultant, and offers some suggestions for remedying the situation.

The growing unity and interdependence of research and teaching in the work of higher education should receive greater recognition in the administration of Federal support. The division of support as between education and research is increasingly artificial and if pressed unduly will do harm to both the teaching and research functions.

(pp. 1069–1070, 1074)

Effect of research on the teaching function of universities (Levin)

Increased attention to research may result in devoting less time to teaching duties, particularly at the undergraduate level.

This is one of the things we are paying for in a sense for the wonderful benefits we are getting from this large national research program.

That is why I say I think we should think long and hard before we try to convert every or most colleges to research institutions, because I think we would lose something thereby. We would gain other things.

(p. 598)

Effects of Government grants and contracts on the universities teaching programs (Haworth)

[A member of the committee asked the witness to comment on the criticism that in the universities and colleges which have received Government grants and contracts the Government work has absorbed the faculty with resulting adverse effects upon the teaching program. The witness replied:]

I do not subscribe to that belief. I have heard it expressed many times. I firmly believe that "to be a really vital educational institution in the sciences it is essential that there be active programs of research, and that the very people who are doing the teaching must do the research." Both graduate and undergraduate teaching is included in this belief.

I think, therefore, that the support of the Federal Government to research in the universities has been a very great thing that has made the universities far better than they otherwise could be.

(p. 50)

Effects of Federal support of science on the teaching function of the universities (Kirk)

The obligation of the university, in terms of the national interest, is just as great in the field of research as it is in teaching, and both should be encouraged in proportions that are properly balanced. The charge is often made that the best teachers become absorbed in research, reducing their effectiveness as teachers.

* * * These generalizations, I think, are dangerous. The most effective university scholar is a man who combines teaching and research. * * * I don't believe that there is any danger that our major universities will be transformed into research institutes. Their current research commitments are more of a positive aid than a detriment to teaching.

(pp. 341, 350–351, 356)

Federal aid for curriculum reform (Kerr)

Federal support should be given to aid universities in their efforts to reform curriculum, in response to recent changes in knowledge. The National Science Foundation currently supports such programs in reform of the physical sciences curriculum.

The National Institutes of Health, however, cannot now support the much needed reform of curriculum in biological sciences.

(p. 1026)

Stimulation of advanced education (Berkner)

* * * Our whole Nation is suddenly awakening to the imperative need for training our men and women to advance levels in science and technology; to building up our graduate schools in every major metropolitan area; to creating opportunities for postdoctoral training, and really advanced research; so that our industrial growth can remain competitive.

In stimulating education at the doctoral and postdoctoral levels, Congress should give mature consideration to the effects of present educational restrictions on grants to research. Research and graduate education are closely identified at many points:

(*a*) Graduate teaching is sterile unless the faculty participate actively in research. Without research, teachers at graduate level become stereotyped and outmoded.

(*b*) A graduate student must be trained in methods and procedures of scientific research by actual participation under scientific leaders. He can no more become a scientist by merely reading books than can an airplane pilot learn to fly while sitting on the ground.

(*c*) Some of the most significant new insights into scientific problems come from fresh new minds in early contact with their problems.

Therefore Congress should *encourage*, not discourage, the affiliation of graduate students and postdoctoral "interns" with *all* programs of fundamental research. Research programs can train new scientists at little additional cost.

The shortage of doctoral candidates in many parts of the country is critical, and Congress should address major attention to this problem with the purpose of defining new ways in overcoming the deficiency. At least 1 great graduate institution is needed in each of our 100 great metropolitan areas. Moreover, the great national laboratories should be encouraged to take a more active part in graduate education.

(pp. 436–437)

Teaching vs. research (Kerr)

To aid the teaching function of universities during the years of swollen enrollments ahead, Federal agencies in the future should allow postdoctoral fellows and research professors to teach one-quarter or one-third of their time without cost to the institution.

Research career professorships may not be necessary to good research and it is not necessarily good for an institution to have professors out of normal academic life. Further creation of such professorships might well be examined.

Universities should make teaching assistantships competitive with research assistantships and fellowships.

(pp. 1025–1026)

Universities' responsibility to their educational function (Killian)

Universities must not dissociate research from scientific education, and education must not be neglected because of attention to research. Research must be conducted and controlled to fulfill its educational function. Especially important is the use of research to strengthen undergraduate education, rather than permitting it to facilitate ne-

glect of undergraduate teaching. "Teaching must not become a poor relation of research."

(p. 756)

E. Role of the Universities in Basic Research

Basic research as the purpose of Federal research aid to universities (Scheps)

* * * the Federal Government's approach to research in the universities should be recognized for what it is—investment by the Government in research activities that are predominantly basic in their orientation, conducted by institutions naturally and heavily involved in education.

Funds directed to university research, we believe, cannot always be regarded as cash outlays for specific purposes. Except incidentally, such funds cannot be regarded as "aid to education."

Research funds placed in the universities must be used to solve problems, to provide special facilities for inquiry, to provide graduate training, and to stimulate the growth of the research impulse.

(pp. 918, 922)

Basic research in the universities (Long)

Some countries, particularly on the continent of Europe and the U.S.S.R., have favored separate research institutes but, implicitly, the United States has made the decision that the very large fraction of the expansion in basic research should occur in the universities.

There are many reasons why this decision was made. One was that the universities were "tremendous reservoirs of scientific and scholarly talent." A much more important reason is that there is a most important favorable interaction between teaching and research. For these reasons

* * * it seems to me that the active kind of Federal sponsorship and support now existing is correct and should be continued and indeed expanded.

(pp. 475, 478–479, 482–483)

Competition for Federal R. & D. money (Kerr)

Industry, the universities, and Government laboratories are becoming involved in competitive struggle for R. & D. works. Universities should be given preference for basic research and for research related to graduate education.

(p. 1025)

Effect of Federal support of science on basic scientific research in the universities (Kirk)

The charge is made that Federal funds divert the universities from their true function, which is pure or basic research, to an undue emphasis upon applied research. So far as Columbia University is concerned, 80 percent of the Federal funds expended in support of research goes to basic research.

* * * it is my judgment that if any institutions have unduly sacrificed their primary commitment to basic research, this is not the fault of the Federal program which has always recognized the value to the Nation of encouraging universities to concentrate their work in the basic research fields.

This is as it should be because basic research is the thing university people want to do, and do best. Often such research suddenly develops practical applications of great merit.

(pp. 342–343, 351–352)

Relative roles of the Government, universities, and industry in basic research (Haber)

We believe that some Government in-house research is necessary, chiefly to maintain a base of competence from which to guide the research of universities and industry. We would like to commend and support recent efforts to improve the administration of in-house Government research. At the same time we see no need for the Government as such to build up its own research industry beyond the present ratio that it maintains with universities and private enterprise.

(North American recognizes the universities') role as a foundation of our national bank of knowledge. We are also dependent on them as the only source of the new technical talent that is so crucial in our operations. * * *

Government-supported basic research in the universities is in the national interest and is necessary to their educational role. We are concerned over any factor tending to dilute this role.

Granting major R. & D. contracts to universities can hamper their educational function and turn them into nonprofit businesses. The aid which universities get from funds from these contracts should be furnished in some other way.

* * * (North American) believe that it is extremely important to conduct our own basic research for two primary reasons: First, * * * we can emphasize areas of basic research that are closely related to our overall activities. * * * And we also need to have an in-house capability which can be relied upon to translate and communicate new scientific advancements directly to the other portions of the research and development spectrum in our company. Secondly, when the scientists conducting basic research are aware of our engineering needs and problems, an environment is created in which basic phenomena can be directly applied. * * *

(p. 606)

The university as the primary center for basic research (Wilson)

The modern university should be the primary center for basic research, rather than new federally owned and operated research centers divorced from university campuses.

The modern university exists for three purposes: (1) To serve the needs of the community and Nation; (2) to discover new knowledge; and (3) to transmit existing knowledge to and train the next generation. The first two purposes are served by other institutions than universities, but the universities

have an almost absolute monopoly on the third. Research institutes divorced from university campuses are virtually sterile in terms of producing the next generation of scholars, and they can be staffed only by draining away from university campuses many of those best qualified to teach.

Thus it is often a mistake to separate the research process from the educational process.

(pp. 508–509)

The universities as the principal source of basic research (Haughton and Smelt)

I think we think in our corporation generally that basic research is for the universities, and we feel like they are more capable of pursuing it oftentimes than we are. This does not mean that we may not do some of it, but not very much of it.

[In response to the question of whether it is entirely fair that private industry should take the position that they have no responsibility in the field of basic research taking into account that the use of basic research leads to applied research and then to corporate profit, and that a lot of the basic research is in fact subsidized by the taxpayers through various forms of aid, this answer was given:]

I think we have responsibility, and I hope we fulfill this in our taxes, in our grants to colleges and our taxes for State-supported institutions and in our scholarship programs.

We are hard and fast on this definition that basic research is pursued for its own end and out of natural curiosity. We tend to just do a very small amount of that because automatically in an organization like Lockheed one asks immediately one has a research result, "Well, that is fine, what can we do with it," and it automatically becomes applied research.

[Further discussion developed the idea that] the basic research programs are inevitably a part of the overall public educational system, and that there is no way to avoid having it as a part of the educational structure which is supported by the taxpayer. Further, there seems to be no way to effectively disassociate the cost of basic research in order to say that industry should contribute this and the public should give that. The public would appear to be the general beneficiary of its results.

(pp. 107–111)

Validity of emphasis on basic, as distinct from applied, research as a use for Federal funds (Kirk)

By their nature and commitment the universities are the best agencies for basic research, although great contributions have been made by industrial organizations and Government research agencies.

* * * The Federal Government has no reason to be apologetic for its support of this university activity. Were it to do otherwise it would be derelict in its duty to our people.

(pp. 347, 353)

F. Federal Support of Educational Research

Adequacy of Government support for research in education and related behavioral sciences (Flanagan)

There have been insufficient Government funds to support all of the promising requests received for research in education and the related behavioral sciences.

The amount of support being given to research on educational problems is only about one or two-tenths of 1 percent of the total budget for education, which now exceeds $20 billion a year. The effectiveness and efficiency of schools and colleges is a matter of great national importance and requires much more research to provide a sound basis for improvement. Policy statements and recommendations

by the CED (Committee for Economic Development) and the White House Conference on Children and Youth have underscored these needs.

Certainly a review of Government research such as that being undertaken by your committee should give careful attention to the balance of our Nation's research and development efforts. There are many who feel that education and the study of human problems in general have not been given an appropriate share of Government support.

(pp. 929–930, 933, 935)

Federal support of research into the educational process (Killian)

I stress the urgent importance of more research on the educational process itself. Education represents a national expenditure of the order of $30 billion; yet the amount of research we do to make education better is minuscule—perhaps only a few million dollars.

Additional support, particularly from the National Science Foundation, should be made available.

(p. 756)

Need for Federal support of educational R. & D. (Stiles)

While the education quality gap has been widely publicized and deplored, there is a basic fact involved which seems not to have been so well understood.

* * * educational obsolescence will not be overcome by public edict and exhortation. Nor is there time to permit schools to test their traditions against a new generation living in this age of rapid change. Closing the education quality gap in time to guarantee continued national progress requires immediate and substantial investments in educational research and development. Federal support for research and development to improve schools is an imperative of the times. It represents, perhaps, the soundest type of assistance to education. * * *

Certain research and development programs supported by the Federal Government have made significant contributions toward improving education in elementary and secondary schools and colleges.

These programs include the National Science Foundation's work in reorganizing curriculums and re-training teachers of science and mathematics; NASA's basic research; the research on programed instruction of the Air Force; and other smaller programs.

The Federal investment in the above programs have been modest indeed, while the improvements which have come to education in recent years may be attributed in large part to these efforts by the Federal Government and philanthropic foundations.

Evidence indicates that investments in educational research are producing knowledge and its applications to improve schools at a rate substantially higher than has been experienced by research expenditures in certain other fields.

(pp. 1060–1061)

Requirements for Federal support of educational R. & D. (Stiles)

Under the Cooperative Research Program of the U.S. Office of Education funds have gone to the projects and researchers judged by impartial experts to be the best. Because of inadequate appropriations, many worthy projects have been bypassed. The limitation of funds has likewise made it impossible to support certain types of research that might have been of great value to education in the

future. Curriculum projects showing the greatest promise and basic research closely related to rather immediate educational gains have received highest priority. CRP projects are jointly supported by institutions and State education agencies, and studies have shown that $1 of Federal money invested in educational research has produced $2–$3 of State, local, or other monies—thus demonstrating that Federal investments for research in this field attract investments from other sources.

* * * With the sound and successful experience that has been gained, the need now is for substantially increased support to permit research and development to go forward on a broader front. Curriculum updating and reorganization and teacher retraining are needed in the social studies, humanities and technical fields as well as in the sciences. Substantial research support is required to mount programs of field testing and demonstration to disseminate the results of basic research to local school systems. * * * to improve the scientific talent of the Nation, the total education quality gap must be closed.

To close the education quality gap the Federal Government should move in the next decade to investing a minimum of $200 million annually on educational research and development. This amount represents only about one percent of present yearly expenditures for education at all levels—elementary, secondary and collegiate. It would need to be supplemented by local, State, and institutional funds, as well as grants from industry and philanthropic agencies, to bring it to the 5-percent level—$1 billion annually—to offer hopes of the kinds of educational breakthroughs that will make and keep the United States a world leader in education—and, hence, in all fields.

Educational programs are frequently characterized as being from 25 to 40 years behind the life of their times. * * * Recent advances * * * have greatly accelerated the rate of educational obsolescence and, consequently compounded the contrasts between what the schools teach and what students need to know.

* * * Teachers prepared, courses developed, and textbooks written this year will be obsolete in 5 years unless provisions are made to keep them abreast of new knowledge * * * The simple fact is that evolution in education is not adequate to keep pace with the revolution in science. The need is for scholars—academic as well as pedagogical—to press forward the persistent task of bringing and keeping educational programs and instructional services abreast of the rapidly changing times. It is for this mission that Federal support for educational research and development is needed—in substantially greater amount, for research, bolstered by adequate programs of demonstration and implementation, is the key to closing the education quality gap. * * *

(pp. 1061–1063)

Research and pilot programs in counseling, guidance and training; also research on educational processes in general (Biemiller)

If science and technology are not to be allowed to run amuck, this fundamental imbalance in our research effort must be corrected. We need research and pilot programs to improve our counselling and guidance and training efforts and to help high-school dropouts, older people and those who have never acquired sufficient literacy to adjust to the new technology. We need more research on educational processes in general at a time when education has become more important to economic success than ever before.

(p. 958)

Under-expenditure on research to improve elementary and secondary school educational programs (Stiles)

Despite sizeable appropriations for research and development in various fields, the amount of Federal funds appropriated for research to improve educational programs in our elementary and secondary schools is woefully inadequate. * * *

Should the entire amount of $42 million of the National Science Foundation budget allocated to the strengthening of science and mathematics teaching, be added to the $11.5 million appropriated to the Cooperative Research Program of the U.S. Office of Education, and to other Federal funds available to support educational R. & D., "the total would still be less than one-half of 1 percent of annual congressional appropriations for research."

The amount of the Federal research budget allocated to discover and demonstrate ways to improve elementary and secondary schools is so small, in fact, that it usually is ignored by those studying Federal expenditures for research. It is hoped that the Select Committee on Government Research will call the Nation's attention to underexpenditures on educational research.

(pp. 1059–1060)

G. Universities' Responsibilities

Abuses in universities in use of Federal money (Kerr)

There have been some abuses of the use of Federal money at the universities, due partially to the fact that universities often do not have actual control of the funds of the Government-supported research programs.

Funds are sometimes diverted from the project intended by the granting agency to another not so intended.

Faculty members often exchange consultancies on each other's projects and thereby accumulate a substantial income.

Abuses may be compounded by the fact that often faculty members are on the panels that choose grant recipients.

Often unnecessary amounts of expensive equipment are purchased with Federal money.

Some universities recruit personnel by promising income, additional to their salaries, from Federal grants.

In a small minority of situations self restraint has not been restraint enough; as one result, greater external restraint will be imposed via increasingly specific agency controls in the large majority of situations. Universities will have to exercise more stringent internal controls in a process of centralization of authority, particularly through the audit process. I earnestly hope, however, that ways can be found to preserve the flexibility that is so essential to creativity. The price for administrative tidiness can be too high.

(p. 1023)

Administration of large nonprofit laboratories by universities (Killian)

In the future some way, other than by the universities, should be found to sponsor or administer the large nonprofit laboratories. These are burdensome to the university, and are not a part of its academic program. Considering the particular period we are in, the university has been called on because it has special skills and climate and atmosphere that make research flourish, and the big laboratories have been managed successfully.

* * * we need to give more thought down the road in the future as to how future establishments of this sort are going to be handled in this country without always turning to the universities to do this kind of job.

* * * * * * *

* * * it might be well if we found another kind of sponsorship or administration. If we cannot, then I think the universities have no choice but to continue to do it.

(pp. 766–767)

The effects of Government support of research on the personnel policies of universities (Killian)

The universities have the responsibility to keep their own house in order and not to misuse nor misrepresent the aid received from the Federal Government. Extreme practices of this sort are the exception, but the universities, not the Government, should take responsibility for eradicating them. Problems of conflicts of interest on the part of faculty members should be taken care of by the faculties.

(pp. 756–757)

Extent of universities' participation in the national research effort (Wilson)

The universities' part in research and development activities is small in terms of dollars while of the utmost importance in terms of the contribution to our Nation's future.

Of the $15 billion currently earmarked for Federal R. & D., only 7 percent is expended in colleges and universities. However, their contribution should not be underestimated. While it is true that not more than $1.5 billion of the 1963 expenditures is going into the search for new knowledge (basic research), "it is to this search that the universities' efforts are and should be devoted."

(p. 507)

Federal aid to campus building (Kerr)

Federal aid furnished by the FHA for building residence halls, student unions, and parking facilities for universities should be continued and expanded, as should the programs under the National Defense Education Act. Almost all colleges and universities in the country have benefited from these programs.

(p. 1026)

Government support of universities (Feldmann)

When Government supports university research programs, primary responsibility for carrying out the research should be in the hands of the university.

The most desirable form of Government assistance to universities is provision of building funds so the university can use its own funds to conduct and supervise research and those facilities.

(pp. 881, 885)

Institutions of higher education as national centers of education (Levin)

* * * There are no State or national boundaries to knowledge and information, and we at Brandeis, for instance, get students from all over the country and from many parts of the world, and then they go back to where they came from or wherever they wish to go.

And so we are not just serving Waltham, Mass., by any means. We are serving the whole Nation. I think I would like to see institutions of higher education more and more become national centers of education rather than strictly local ones.

(p. 599)

Proper basis for the charge of research salaries on federally financed research (Scheps)

* * * research salaries should be charged on the basis of effort expended to research agreements and the charges reviewed at appropriate intervals to make certain that they are correct.

* * * these reviews should be conducted at the ends of normal academic terms, rather than on rigid periods of the fiscal calendar, so that reports of efforts expended on research agreements may be made on normal institutional schedules.

(p. 920)

The proper spectrum of research in the universities (Bailey)

Basic research (meaning a search for new knowledge) has been the traditional function of universities and should be so continued. However, there is also justification for engaging in applied R. & D. in order to offer instructional programs of excellence in certain areas.

As we move along the research and development spectrum, we find the professions increasingly concerned with and active in applied research and development. This must be true if they are to provide the proper education and training for the future practitioners in these professions.

These applied activities not only serve as an essential function in the education of undergraduate and graduate students; they provide a constant flow of new and improved products and procedures for man's benefit. And they do even more; they identify new problems and point the way to new approaches in basic research.

(pp. 872, 873, 874)

Responsibility of the university in the administration of research programs (Bailey)

There should be appropriate machinery for review of proposals to assure that all support accepted is for work directly related to the university's objectives as an educational institution.

Second, the university should resist the temptation to expand research programs—regardless of their inherent value—beyond the level where there is the proper balance between teaching and research in the participating department.

Third, the university should be as careful in the fiscal management of grant and contract funds as it is with its own appropriated funds or direct contributions. * * *

(pp. 875–876)

University officials administering Federal research programs (Jones of HEW)

There is a very considerable amount of detailed administrative work for a university in preparing applications for grants.

[The universities] need more of them, because it would be tremendously advantageous to the institution, to the investigators and to the Government if there was more attention to the administrative details of the presentation on the part of the institution.

(pp. 556–558)

H. Academic Freedom and Independence

Control over research vs. academic freedom (Foster)

There is a problem of maintaining balance between the responsibility of the Federal agencies to see that Government money is wisely spent by the universities, and the need of the universities to maintain their freedom to pursue new ideas.

(p. 776)

Diversity of support for universities (Killian)

"In the most ideal of worlds," there might be an important degree of freedoms if all funds came from private sources. But in our kind of society, it may well be that we gain from having a mixture of these funds.

* * * But I also feel that we must be very certain that our private institutions remain strong in the sense of having enough private funds to maintain their independence, and to reject any kind of proposals coming either from the private sector or the public sector that tend to encroach upon their independence.

There is no more freedom in selecting subjects for research under Federal moneys or under private moneys. There is growing recognition in this country that the universities need to have unrestricted funds, and there is a recognition in Government that this is important.

(pp. 768–769)

Effect of Federal research assistance to universities on private contributions (Killian)

There is no drying up yet of private sources of funds. The opportunity for private sources of funds to supplement what the Government is doing is tremendous, and there is a growing recognition that the diversity of private and public support is an important combination for maintaining this independence and balance of activity in our universities and colleges.

(p. 763)

Effect of Federal research programs on academic freedom (Wilson)

There is the possibility that academic freedom may be abridged by the increasing flow of Federal funds into university research projects.

* * * There is always this possibility. I think it has to be guarded against. I think in terms of the past record, though, we can be very much reassured. I have been associated with both public and private institutions where funds have come from a variety of sources, and my personal observation has been that Federal funds carry as little interference and attempt at control and restriction, and so on, as any source of funds that you may get from foundations or from State legislatures, and so on and so forth.

The red tape of accounting for expenditures by universities receiving funds, while necessary, should be kept at a reasonable minimum.

Although it does not involve the principle of academic freedom in the traditional sense, there is a possibility that university recipients of Federal research funds may feel a certain restraint in criticizing the program.

(p. 512)

Effect of Federal support of science on the independence of universities (Kirk)

It is charged that, at times, universities may lose their independence because they have accepted such large Federal grants and contracts. The issue in my experience is largely a strawman.

In the past 10 years I can recall no instance when Federal agencies have used this financial lever to try to influence educational policy at Columbia.

It is well recognized, as fully in Washington as in the academic community, that the independence of our universities is a precious national asset.

* * * I see no evidence that this independence is being—or is likely to be impaired, simply because our Government has recognized that it can enrich and secure the Nation's future if it helps the universities carry on work which they want to do, which Government agencies are not well staffed to do, and which the universities could not do if Government funds were unavailable. I do not lose any sleep at night because nearly half of my university's gross operating budget comes from Federal research support.

(pp. 343–344, 352, 355–356, 357)

Effect of Government research contracts on outside institutions (Denney)

How is independence of mind in foreign policy research to be protected? What are the conflicts of interest in research upon which the Government can have some effect one way or another?

The impact of Government requirements is now of a size which influences the whole Nation's research effort. We rely on the outside institutions for the experts the Government recruits, and tempt the scholars with contracts. At the same time, the Government supports programs and investments which the private institutions could not otherwise undertake.

(pp. 185, 194)

Effects of Federal research aid on university autonomy (Kerr)

Because of Federal programs, universities have lost some control over their own affairs. Because negotiations are carried on between an individual and a Federal agency, the research funds obtained do not enter the university's normal budget review, even though this funding does commit some of the university's funds, influences the assignment of space, determines distribution of teaching and research time, and determines areas where the university grows fastest. All this sets up an imbalance in the institution.

(p. 1022)

Federal control and influence on universities (Kerr)

Federal control of universities is not a problem, but Federal influence is. For example, a university can seldom turn down an offer of a project from a Federal agency, because, if it refuses, it is in danger of losing the faculty member who negotiated the grant.

(p. 1022)

Preservation of traditional university freedom in research (Killian)

Individual researchers should not be overburdened by Government requirements for accounting, reporting and recordkeeping. They are usually not qualified to do this and it diverts them from creative work. The time-tested environment of the university has been, and must continue to be, protected. Government policing of funds should not reduce the freedom to pursue research, nor damage the special environment created for education and research. "This special environment is a national resource that needs vigilant protection."

[The question was asked—How can we compromise the plea to respect the university's freedoms, and at the same time give the university more money and also discharge Congress' responsibility?]

There is no easy answer to this question. However, there is very little evidence of any real encroachment on academic freedom.

* * * I am not one of those who is pessimistic about having the kind of administration and the kind of conditions governing Government funds that insures their being spent in the public interest, but also protects the academic freedom of the university. I think it can be done.

(pp. 754–755, 767–768)

Wide range of support for university research (Heald)

It is important that universities continue to have some wider range of choice in the sources of support, including private foundations, business and industry, and State and local governments, as another guarantee of their independence.

(p. 387)

I. Federal Agency-University Relationships

Broader panels to evaluate research proposals (Kerr)

Panels which review research proposals should be made up of representatives of related fields, not just representatives from the field under review, to insure greater impartiality and judgment of a proposal in relation to the rest of science.

(p. 1025)

Centralization of Government research support to universities (Kirk)

The Government should avoid having research to universities channeled through too few agencies. Further centralization would lead to a decline in the quality (if not the quantity) of work because problems are too diverse to be filtered through a single granting agency. Decentralization will lead to better technical decisions.

The present situation may at times appear to be confusing, but I think it is a very productive confusion, and I think it is to be preferred.

(pp. 347, 353–354)

Establishment of a national foundation for higher education (Kerr)

A national foundation for higher education might make grants in areas where Federal support is needed, but which are not now covered by the National Science Foundation. The new foundation might sup-

port regional library resources with union catalogs made available to other institutions of higher learning in the area.

(p. 1026)

Evaluation of Federal research administrators (McConnell)

In general we have found the specific programs directed by the various Federal departments and agencies to be "well thought out and well managed." So far as our experience is concerned the Government research administrators are "able, dedicated men, well respected by their peers."

(p. 863)

Need for uniformity in accounting procedures of different Government agencies in contracts with universities (Kirk)

Universities could devote more time and energy to research and teaching if there were uniform accounting and reporting procedures used by the different Government contracting agencies, instead of the variety of procedures now used.

Contracting regulations relating to basic scientific research should be more flexible than the regulations for other types of research.

(pp. 345, 353, 361)

Present pattern of operation between universities and Federal agencies (Eisenhower)

A valuable store of experience exists in the history of Federal-university research relations.

The improvisations of World War II evolved into fairly uniform practices which, with minor variations, have persisted. I urge your committee to take account of the painstaking and detailed studies which have produced the present relationship. * * * They are no longer a matter of improvisation; they have been carefully tested over the years and gradually modified in the light of experience. There is much in the present pattern of operation that is good, and which should not be discarded without persuasive reasons which are surely not evident to me.

(p. 994)

Problems in direct relations between Federal agencies and universities in sponsored research (Rose)

Such problems no doubt exist in the general situation, but they have been minor at the University of Alabama.

* * * There has been little evidence of any desire on the part of agency representatives to attempt to "tell" university personnel how research should be carried on. Administrative problems that arise in the conduct of research generally are solved with little effort. In fact, agency representatives consistently are people who know their jobs and display a remarkable understanding of problems confronting the university, both technical and administrative.

(pp. 790–791).

Proximity of Federal research centers to universities (Kerr)

Federal research centers should be near to and identified with a university. The university atmosphere is favorable to research, and the centers will provide research opportunities to faculty and students.

(p. 1025)

Relationships between National Science Foundation and State departments of education in placing grants for research (Haworth)

[A member of the committee stated that he had received communications alleging the NSF did not consult with the State departments nor take their wishes into consideration. Dr. Haworth asked the Deputy Director of NSF to answer the question.]

This probably is a complaint against the science education program of NSF. NSF has

> * * * had a working understanding with the Office of Education programs where the science education programs from the Foundation come into meeting with the science education programs that are funded from the Office of Education. Generally speaking, we have tried to divide the point of contact by having the Office of Education work through the State departments of education and we have been working through the science departments of the universities, so that I think it really has been a matter of coordination and division of labor.

(p. 53)

The role of the National Science Foundation (Wiesner)

> The National Science Foundation is moving to fulfill such a role for Federal policies in many important areas of science and education that diverge from the primary interests of mission-oriented agencies and to serve thereby as a special guardian within the Government of the health of American science. In this effort, the NSF must assume a greater role in the support of fundamental research focused on national needs.
>
> * * * In its fiscal 1964 budget request, NSF sought to meet these important needs and thereby rationalize somewhat the current pattern of multiple support. Cuts in the NSF request are jeopardizing this important objective. Surely one should recognize * * * the importance of overcoming the differences of perspective * * * that characterize the congressional and executive approaches to Government-wide science programs.
>
> The Science Foundation has been an extremely important element in the continued development of our research programs in the Nation, but in my opinion it has never been adequately supported when one puts it up against the other Governmental agencies that have been supporting science. It has been much easier to get money for the mission-oriented activities and to carry a fair element of basic research along with that than it has been to support basic research or the educational activities related to them in the Science Foundation.

(pp. 264–265, 268–269)

Varying policies and procedures of Government agencies supporting research projects in universities (Steimke)

Universities performing Government-supported research are disconcerted by the many different policies and procedures in the various Government agencies.

> * * * Researchers are frequently encouraged to submit proposals for the performance of a piece of research to several different agencies on the theory that in this way the proposal has a better chance of coming to the attention of someone who feels it is appropriate for his agency to fund the work. Because of differences in allowable overhead charges by the different agencies, this results in an

offer to do the work for one agency at a total cost which is different from that proposed to another agency. It is difficult for us to understand why such variations exist.

(p. 616)

J. CONTINUITY IN FEDERAL GOVERNMENT-UNIVERSITY RELATIONSHIPS

Continuity of support to universities where basic research is being undertaken (Eisenhower)

* * * Basic research—the kind which universities do best—is a continuous undertaking. This fact is recognized by sponsoring agencies which, year after year, have extended support to scientists in whose abilities they have confidence. Yet grants must be renewed frequently, often annually, and funding is, of course, dependent on annual congressional appropriations. * * *

Delays in processing-grant renewal applications, or failure by the Congress to provide the necessary funds by a certain date, frequently frustrate the intentions of sponsoring agencies to provide long-range support to projects.

When these situations arise the universities are faced with hard decisions; they may cut off expenditures and dismiss supporting staffs, * * * or they may advance the funds necessary to carry on the work in the hope that eventually they will be reimbursed.

In all probability, universities have chosen the second alternative—that of advancing funds, with perhaps no more serious loss financially than the lost interest on the advanced funds. However, the uncertainty does have adverse effects on the research program and the institutions where they are being conducted.

I strongly urge that Congress attempt to find a means of correcting this situation so far as it is possible to do so. The objective should be continuity of support when such support is justified. To this should be added a mechanism for providing adequate advance notice if termination is contemplated so that the investigator and the institution can make necessary adjustments in their plans.

(pp. 995–996)

Effect on the university of termination of Federal research aid (Steimke)

Established research programs can be, and frequently are, terminated, leaving a group of people to be supported from Georgia Tech funds until they can obtain Federal funds for another project.

* * * A sizable research organization such as ours develops competence in certain areas by assembling groups of qualified people and by providing them with the facilities and space which they need. Such teams of competent people work closely with scientific persons in the sponsoring agencies. Sometimes a program is supported by a Federal agency because some single individual in that agency is interested in the program. * * * If that individual leaves the agency, his interest in the program may not be picked up by some other person. In such an instance, it may be difficult for the institution to secure funds to carry on the work. This may mean that much of what has already been done will have been lost.

(p. 615)

Effects of Government policy changes on university research personnel (Steimke)

Sometimes changes in policy affect university personnel adversely. A case in point is the recent decision, by the National Science Foundation Board, limiting to 2 months the time that a faculty member can be engaged during the summer on an NSF project. Only in the most unusual circumstances will more than 2 months employment during the summer be authorized. Many faculty members find it necessary to work the entire summer in order to meet their financial obligations. This action by NSF will encourage qualified researchers who should be engaged in research to seek summer employment of a different type.

(p. 616)

Federal research grants to universities must be maintained at least at present levels (Hutchisson)

To assist the universities in training the number of scientific personnel which the Nation needs for teaching, for industry, and for the Government,

the Federal Government must provide help with research grants to universities, at least at the present scale, but probably an increasing one as the numbers to be trained increase.

(p. 1019)

Maintenance of continuity in Federal research projects in the universities (Steimke)

There is a need for better assurance that worthy programs will be sustained. This calls for a careful evaluation of programs before they are initiated and an establishment of priorities within the sponsoring agencies to assure that the effort is being placed where the need is greatest. Georgia Tech is doing an appreciable amount of research for * * * the Department of Defense in areas in which we have competence beyond that which could be found anywhere else. This research is performed under contract. Generally, the contract period is 1 year. It is continually necessary that research personnel in these groups seek sources of funds for continuing their programs. This is a time-consuming and costly procedure. It usually takes many months to locate appropriate Government personnel and arrange for funding to accomplish even the most critical short-term program required to evaluate the plausibility of a novel idea which has arisen as a byproduct of a piece of contract research. There is need for improved flexibility in funding for defense-oriented research.

* * * much calendar time and the talents of scientific managers and researchers can be conserved if funds could be provided to a competent research team each year, based on a percentage of that team's previous annual income or expenditure from contracts for Department of Defense research. * * * it would seem to be in the best national interest to permit them to pursue military-oriented programs of their choice. Precedent for this philosophy and procedure is contained in the institutional grant support authorized for and partly implemented by the National Institutes of Health. * * *

(pp. 615–616)

K. Institutional Grants vs. Project Grants

The block or institutional grant to the university vs. the project grant (Flanagan)

The institutional grant program may be a more beneficial form of assistance to the universities than the project grant.

There certainly is a place for helping the individual researcher [through project grant] * * * to help the person in an institution which is not itself sufficiently strong to get a block of funds but who has a good idea and needs some help.

On the other hand, I entirely agree that the big progress in educational research in the next decade or decades is going to come through the larger programs, that is, the little project only very occasionally really moves us very far ahead. One needs a substantial effort over a period of years to really get solutions to problems and get them into educational practice. * * *

(pp. 932, 934)

Broader research programs for educational institutions (Rose)

Educational institutions should be given broader responsibilities and broader research programs in order to produce better research. The present practice of awarding grants to an individual on the basis of a proposal submitted is inadequate. The capabilities of universities and colleges should be used more often for broad research programs.

(p. 792)

The categorical grant versus the institutional grant (Eisenhower)

* * * One may argue strongly on either side of the issue, but I believe it would be a serious mistake at this time to shift radically from categorical grants to institutional grants. Such a shift would entail difficult administrative problems for both the Government and for the universities. * * *

More experimentation with the two methods, as initiated by NIH and NSF, and close observation of their results might suggest a proper balance between project and institutional grants methods.

* * * Although I oppose *supplanting* project grants with general assistance, I by no means oppose *supplementing* project grants with institutional grants. I * * * see real merit in general Federal assistance to colleges and universities for programs and, particularly, for academic facilities. * * * it is definitely in the national interest for the Federal Government to give substantial financial support to American higher education in general. * * *

A program of general support, as suggested above, would require careful thinking, and

to be most effective should involve the States significantly and require them to increase their allocations to higher education.

(p. 995)

Combination of institutional grant system and limited-term project system of distributing Federal research funds to universities. (Fawcett)

We believe that the interests of the country require support of basic research through an institutional-grant system as well as through continuance of the limited-term project system. Excessive reliance on the project system involves the difficulties and expense of attempting to manage thousands of individual projects through central staffs, review panels, and the like. More importantly, it involves the centralization of the function of judgment of what is and what is not likely to constitute an important and fruitful line of research. The whole history of research shows that it is unsound to place in the hands of any group * * * the all-important responsibility of deciding what individuals, what projects, what institutions, should be selected to carry on virtually all of our research effort. * * *

There is an urgent need for attention to the largely missing component of our research effort: A program designed to strengthen institutional competence in research in a wide variety of institutions. * * *

We believe that a provision for a program involving both broad institutional support combined with a continuance—for some time to come at least—of individual support, would be in the best interests of the country.

The Association of State Universities and Land-Grant Colleges supports the general-grants and the cooperative-fellowship programs of the National Science Foundation and the National Institutes of Health, and other programs of the NSF and of the National Aeronautics and Space Administration which give the universities a greater degree of authority than they had in the past.

(pp. 999–1000)

Contrast between broad grants to land-grant universities and specific, categorical grants and contracts from other sources (Eisenhower)

The partnership in the conduct of research between the land-grant colleges and universities and the Federal Government has been long, fruitful, "eminently satisfactory," notably lacking in fiscal abuses, and of indisputable benefit to the Nation. The imposing partnership of today began early in World War II, grew to larger proportions during the Korean emergency, continued to develop since then, and may now, I think be considered a permanent policy of the Federal Government and of the universities.

One major change has occurred in the relationship. Whereas annual Federal grants to land-grant colleges and universities have consistently and continuously been broad in nature for the promotion of agriculture and the mechanical arts, with broad discretion left in the hands of the universities as to the best methods of implementing the general program, all other contract research presently sponsored by NIH, NSF, AEC, DOD, and other agencies, is specific and categorical in nature. Grants or contracts spell out the administration of thousands of current specific research problems. This change in the sponsored research mechanism has brought attendant problems for the agencies and the universities.

(p. 994)

Desirability of "block" grants to universities (Killian)

The Government should use more "institutional or block" grants to give universities more flexibility in handling the research programs.

(p. 754)

Graduate fellowship program (Kerr)

Graduate fellowship programs should be expanded as there are capable graduate students to fill them.

These could be widely distributed throughout the country, to avoid tying them to a few universities.

The Federal Government should copy the practice of the Rockefeller and Wilson Foundations in making an institutional grant to cover part of an institution's expenses for these fellowship students.

(p. 1026)

The institutional grant as a means of Federal support of research (McConnell)

The research and graduate-education support programs of the Federal Government may be divided into two segments, although these overlap and interlock: (1) those oriented toward direct assist-

ance of faculty research with support and training of graduate students as a byproduct; and (2) fellowship and other direct student-support programs with research a normal and expected part but not the immediate primary objective of the aid.

Allotments to institutions to date have been on an individual basis—either faculty member or graduate student—without real recognition or development of the institution's overall need and responsibility.

I would urge an increased consideration and implementation of support through institutional grants—with proper safeguards for maintaining quality—analogous to the Hatch Act approach. * * *

* * * * * * *

There are additional arguments for the institutional-grant concept. A national concern exists that the big grow bigger at the expense of the small who grow smaller and that the centers of research become more and more concentrated.

Dr. Paul M. Gross, chairman of the Board for the American Association for the Advancement of Science, recently expressed * * * this concern and recommended expansion of institutional grants in order to develop many centers of excellence having better geographical utility and effect. We subscribe to his position on this issue.

The institutional grant, in contrast to the mission-oriented agency grant, appears to promise more freedom of direction for university-conducted research, as well as greater stability for continuing research projects.

* * * I should point out that there are researchers who have turned their backs on large-scale Federal support for their projects even though it meant a considerable delay in the attainment of their goals. The reason is * * * what has happened to some research projects supported by mission-oriented agencies which have suddenly changed orientation. * * * Similarly there are many institutions which refrain from hiring additional faculty and staff for research simply because they do not wish to be in a position of letting these people go or of having to support unneeded * * * faculty from their own funds. * * * The recent hold-the-line action of the Congress in regard to the National Science Foundation budget will probably produce a noticeable retrenchment in the conduct of research by faculty.

In summary the justifications for the institutional grants concept are:

(1) The provision for more institutions to improve their quality and seek to achieve excellence.

(2) Responsible freedom for each university for the direction of its research and for the improvement and development of instructional capabilities in keeping with its academic objectives.

(3) The opportunity for the development of a university's various programs with continuity and without fear of withdrawal of support for causes other than nonproductivity and incompetence.

(pp. 861–863, 867–868)

The project system of awarding Federal research funds (Kerr)

Federal grants to universities should continue to be awarded primarily on the basis of projects, rather than on an institutional basis. In the future, with expanding Federal research budgets, this should result in spreading out project grants to more institutions, rather than having them largely confined to a few as in the present case.

Institutional grants should be assigned as some percentage of project grants, these latter to be assigned on merit.

It is suggested that 75 percent of funds to universities go for project grants, 25 percent for free institutional grants. The latter would give

flexibility in using money for new, small projects, support of young faculty, and for neglected fields.

(p. 1025)

Provision for "general purpose grants" (Berson)

I would also urge that the Congress provide general-purpose grants to the institutions in which Federal agencies are supporting research projects and programs.

The recent development of "general research support awards" by the National Institutes of Health and "institutional grants" by the National Science Foundation has been "extremely sound and helpful."

If a significant portion of the funds for the support of research—say 30 percent—were made available as institutional grants clearly intended for the support of the institution, it would be less necessary for Federal agencies and institutions to attempt the impossible task of drawing sharp lines between what is "research" and what is education, service or administration, when they are all closely related and mutually supporting. It would also diminish the danger that large research projects and programs would produce a poor balance within the institution. And I believe that, in many instances, further strengthening of the research program would be a direct result. More importantly, the institution's ability to strengthen those portions of its total program most appropriate at a given time would help insure the soundness of the institution and its ability to make future contributions to the national research program.

(pp. 798, 803–804)

Unrestricted funds for universities (Calkins)

Universities need adequate unrestricted funds to plan effective research programs and to give their programs more flexibility and continuity. "Program financing" should be emphasized to counterbalance "project financing."

(p. 913)

The unrestricted institutional grant (Bailey)

* * * This type grant is highly effective in certain areas of major importance in our long-range objectives: providing opportunity for "seed" research, especially by promising young workers; supporting basic research and training of undergraduate and graduate students who participate in the research work. We feel strongly that this type program should be expanded considerably. It should not, however, entirely replace the competitive-grant program.

(p. 875)

L. Indirect Costs of Federally Supported Research

Adequacy of reimbursable costs on Federal contracts (Levin)

[In response to a question concerning the adequacy of the 20-percent limitation with respect to Federal contracts, and whether the university lost money because of this limitation, the reply was—]

We certainly do lose money. Let me say to you very quickly that it is not only this differentiation in overhead but the university loses money if you want to call it that by establishing a research program, because when you establish a research program such as the one I described for you in biochemistry this costs the university a great deal of money. We pay all the salaries or practically all the salaries of these people. We get very little of this from the Federal Government. You have to maintain buildings. You have to provide

a great many things which cost a lot of money, which are not included or includable in any calculation of overhead.

And so we lose not only on the differentiation in overhead between that which is allowed and that which is true overhead, but also on these others.

But I don't like to use the term "lose money," because it is part of the obligation of a university to support research, and we agree to this, and we want to share in these programs.

We would like to have a little more help from the Federal Government in this total sort of overall support, because what one has to be very careful of is that if one is worrying only about science and expanding science, this can take away from all the other fields of the institution, and get a very unbalanced and uneven institution.

(pp. 601–602)

Allowance for indirect costs in Government contracts with universities (Kirk)

There is need for uniformity in the Government in determining indirect cost allowance rates to enable the universities to administer funds more effectively. There should be a greater centralization within Government of decisions that control the treatment of our indirect costs. Universities now have to deal with hundreds of projects funded under separate programs by many different agencies, operating under different rules and negotiating procedures, and having different methods of determining indirect costs. This makes management difficult.

(p. 348, 354)

Allowances for indirect costs in grants by the foundations to universities (Kirk)

The foundations, which grant money to universities and other agencies to pursue research, are unwilling to make substantial arrangements for reimbursement of indirect costs incurred by the recipient organization.

(p. 346)

Federal provision of space and equipment (Kerr)

Federal agencies should provide space and equipment for their postdoctoral fellows and research career professors and for their contracts and most grants without the requirement of matching funds.

Space and equipment are both difficult for the university to acquire because neither their endowments nor State-support funds are adequate, nor are they entirely appropriate for the purpose.

(p. 1026)

Full reimbursement to universities for indirect costs of Federally financed research (Scheps)

* * * indirect costs—the costs for normal administrative and academic services and materials—should be reimbursed in full to the institutions on a basis as fairly determined by the Government and the institutions jointly. * * * it is impossible for the Government, in fairness, to try to separate the indirect from the direct costs of the research, leaving the institutions to grapple with these and other costs assumed to be educational in nature. The costs of re-

search to the institutions are true costs and the university should be reimbursed for them * * * because these are necessary to university operation and the universities could not operate without these services.

(pp. 918-919)

Indirect cost allowance (Killian)

A way has to be found to cover all indirect costs or the university will be seriously damaged.

(pp. 760-761)

Indirect cost allowance (Staats)

It is questionable whether there should be uniform percentage allowed to universities for indirect costs. If uniform, some get more than actual overhead costs, others get less.

If the established percentage is uniform, there should be special provision allowed where a hardship is worked.

Congress should view this problem as a general legislative problem, not as an appropriations program-by-program matter.

We believe that where it is desirable for the Government to pay the entire cost of research done at a university, it should pay for all allowable indirect as well as direct costs. Congressional action to place a 20-percent ceiling on the payment of indirect costs may create a hardship for the universities that is contrary to the national interest. A thorough study by this committee of the effects of Federal support on the universities could make an important contribution to better understanding of the facts and policy issues involved.

(pp. 569, 590–591)

Payment of costs of Federal research by universities (Berkner)

One of the most troublesome problems of Government-sponsored research at present is the current limit of 20 to 25 percent on indirect costs recovery imposed on academic and nonprofit research institutions by most Federal agencies. Similar limits are not imposed on contract research. Such unrealistic restrictions decimate the universities' own resources and divert the research capabilities of scientists to activities that can more efficiently be done by others. In particular, the small moneys available should be used as "seed" money to develop "long-shot" ideas at a stage where a granting agency would have difficulty justifying a project, or to develop new scientific personnel. Moreover, with a restriction on overhead costs, an institution seeks ways to save administrative expense, whereas supervisory expenditures are really needed to insure sound administration of public funds.

Congress would insure more return for its investment if it allowed up to 35 percent overhead expense against direct costs under research grants. This would:

(a) Release seed money for new research projects from funds now used by institutions on reimbursed overhead;

(b) Encourage institutional support for newly emerging scientists who are desperately needed;

(c) Encourage better internal administration of public funds; and

(d) Permit more freedom of action and an increase in productivity by the scientist.

(pp. 433–434)

Payment of overhead costs in connection with Government-sponsored research (Dickey)

The question of how to deal fairly with overhead cost to institutions is still certainly not wisely settled. Dartmouth has not made money on Government-sponsored research, and we do not believe that we have even covered its full cost to us. It might be worthwhile to investigate having an upper limit on the amount paid by the Government to any single institution for certain types of overhead cost. Up to now the arguments about overhead have not taken sufficient account of the real needs of the strongest research centers and of hundreds of other institutions striving to establish themselves as strong centers.

(pp. 1076–1077)

Recovery by the university of the full cost of Federal research (Rose)

The sponsors of research should pay to the university the full costs, direct and indirect, for the research which they are financing. Cost-sharing in the long run would defeat the major objectives of Federal research and definitely is not in the national interest.

Educational institutions in which Federal research is carried out "cannot remain strong if they are progressively forced to divert their already inadequate funds."

(p. 791)

Reimbursement to universities for indirect costs relating to Federally financed research projects (Kirk)

Universities must be reimbursed for research supported by Federal funds, on a full-cost basis for indirect costs. Reimbursement for *direct* costs is simply a matter of bookkeeping. If a deficit is incurred in carrying out Federal research contracts, universities will have to cut back research. Universities could not derive any profit from research operations nor can they undertake much research involving actual out-of-pocket loss.

Partial reimbursement for indirect costs is impossible because universities simply do not have at their disposal any considerable amount of free funds which they could use for matching purposes.

(pp. 344–347, 352–353, 358–360)

Relations between Government and higher education (Furnas)

The lack of a generally accepted, clear understanding of the interrelations between research and higher education has led to some muddy thinking and perhaps some unwise legislation.

There is an erroneous idea that Government should buy research from universities at a low price and give only little support to the concomitant educational process.

Because of current restrictive legislation, sufficient overhead on Federal grants to universities is insufficient to cover indirect costs. This is very harmful and dangerous to these institutions.

Only a few wealthier universities can carry out the amount and kind of research necessary to advanced education in science and engineering. Result—"the strong get stronger and the weak get weaker * * *",

which is exactly the opposite effect to that which the Congress desires to achieve.

However, even the richest institutions will not be able to continue to be inadequately reimbursed for indirect costs, nor are they in a financial position to carry out the necessary large and expensive research programs unless the major financial burden is carried by the Government or other outside sources.

(pp. 1007–1008, 1009)

Responsibility for payment of indirect costs involved in Government-financed research programs in universities (Steimke)

This problem revolves largely about the procedure and system of assessing what percentages of indirect costs for overhead are made allowable under Federal contracts and grants.

Under contracting agencies

Research performed under contract carries a charge to the sponsor for indirect costs based on a percentage of those personal services charged directly to the contract. Our current fixed negotiated rate is 65 percent. For last year the Army Audit Agency verified our actual indirect costs for research to be about 80 percent. Overhead rates are not a measure of efficiency of operation. They are affected by several factors, most significant of which is the manner of distributing direct and indirect charges. * * * We sometimes find * * * that the persons with whom we are dealing in some of the Federal agencies consider a high overhead rate to be indicative of high total costs, of inefficiency of operation, or even as an attempt to make a profit on the research.

Under granting agencies

Certain Federal granting agencies * * * have statutory or other limitations on the amount of reimbursement for indirect cost which they are permitted to pay. At present, either 20 or 25 percent (depending on the agency) of the total cost for direct charges may be paid under such grants provided the indirect costs are actually equal to those percentages or exceed them. At Georgia Tech we have found that we actually receive only about half of our real indirect cost of performing research under such grants. This means that we must use institutional funds to make up the difference, and this in turn means that the amount of research we can perform for the Federal Government is dependent upon how much institutional research support we can afford. * * *

* * * one result of low allowable percentages for overhead will be to cause the universities to revise their methods of charging so that more of the appropriate charges are made directly to projects. In the long run the net effect to the Government will be an increase in the cost of research rather than a decrease because of the resulting greater complexity of record keeping. * * *

(pp. 614–615)

Sharing of direct and indirect costs between the universities and the Federal Government (Eisenhower)

I believe strongly that the Government should pay the full costs, both direct and indirect, of research programs it establishes in universities. The universities should not be required to supplement Government funds with their own scarce resources in order to maintain a governmentally sponsored research program. On the other hand, universities should receive no financial profit through the Government research they conduct, of this the Government should have positive assurance.

Such a balance can be achieved only if the sponsoring agency assumes all direct costs, and if indirect costs are determined by a standard formula applicable to each individual participating institution. Budget Circular A–21, while not the perfect document for de-

termining indirect costs properly attributable to Government research, has the attribute of applying equally to all institutions.

* * * This element of equal treatment is lost when the Government establishes indirect costs as a fixed percentage of direct costs. In many cases this fixed percentage necessitates subsidization by the university of governmentally sponsored research projects. In others, institutions may receive more than their actual overhead costs. I urge, therefore, that the Congress require all agencies sponsoring university research to adopt Circular A–21 as the basis for determining indirect costs.

Uniformity in the determination of costs, both direct and indirect, does not imply that the Government should consolidate all the funds which it appropriates for university research in the hands of a single Federal agency. Indeed, this would be a grievous mistake. * * *

The diversity of needs, interests, and objectives of various agencies demonstrates the inoperability of having the many specific areas of research supported intelligently by a single agency. Not even the National Science Foundation, embracing as it does a broad spectrum of scientific interests, could conceivably be expanded to encompass all of the research currently sponsored by all other Government agencies.

(pp. 994–995)

Uniform limitations on indirect costs for grants and contracts (Scheps)

* * * limitations on indirect costs imposed by the Federal Government under Federal grants are placing unfair burdens on the colleges and universities. * * *

* * * if limitations are necessary * * * they should be calculated as percentages of the salaries and wages of research programs and thus in the same manner as indirect costs are determined on Government contracts. Such determinations would eliminate the kinds of misunderstandings that arise when an agency attempts to adjust the direct cost base for determining the indirect cost allowance.

* * * * The indirect costs of a university are incurred in the management, maintenance of buildings and equipment, heat and light, maintenance of libraries, and so on. The sum of these costs must be compared to a base to calculate a proper indirect cost reimbursement. We believe that the salaries and wages base reflects more equitably the universities' obligations.

(pp. 919–920)

Uniformity in cost reimbursement to universities for federally financed research (Scheps)

* * * the time * * * must come when the Government and the universities reach a common understanding on the entire question of cost reimbursement. We believe that the Bureau of the Budget Circular A–21, a document evolved over a number of years of experience with cost reimbursement problems, should be accepted by all agencies of the Government for the determination of costs of research supported by contracts or grants.

(pp. 919, 921–922)

M. Distribution of Federal Research Funds Among Universities, Defense of

Determination of policy of Federal support to medium sized and small educational institutions (Waterman)

A criticism frequently heard is that Federal support goes in increasing amounts to the large universities, and that more public funds should go to medium sized and small institutions.

The following factors must be taken into account in deciding upon a policy of broadening the base of Federal support through increased Federal support to medium sized and small institutions.

(a) * * * there are a large number of small institutions which do not wish to encourage graduate work or research, but which concentrate their attention upon undergraduate teaching. Surely this is a matter of their own decision.

(b) Furthermore, it is highly questionable, in my opinion, whether the 1,000 institutions that do not now provide a bachelor's degree in science and engineering should at this stage be considered for research support; their immediate problem is the extension of their teaching to include science and engineering.

(c) * * * The support of high-quality work is the major consideration. * * * My view, therefore, is that the policy adopted by the National Science Foundation is the proper one, namely, to provide for the needs of the highest quality research and the most competent investigators wherever they may be found. As one approaches the limit of available funds, one then has to choose from among a large number of projects, approximately equal in merit and quality, coming from large and small institutions, from all sections of the country and from experienced and youthful scientists. Under these circumstances, with similar quality, one can furnish preferred support to young investigators, to small institutions, and to improving geographic distribution.

If smaller institutions wish to get into the field, the Government should consider institutional support which would enable them to strengthen their science, "and not attempt to put research money into inexperienced hands."

Under the policy I have outlined, a broadening of the base of support can be accomplished automatically by providing more total funds.

(pp. 813–814, 821)

Distribution of research funds among universities (DuBridge)

Charges that distribution of research funds are made in unfair fashion, and that the rich universities get richer as a result, are not in accord with the facts. No school gets rich doing research, and the research must be done by those schools which have built up the necessary staffs and facilities to carry on research and graduate studies. Funds are allocated in very close proportion to the graduate student population of a State, and this is closely proportional to total population, according to an analysis made by the National Science Foundation. Obviously, you cannot place a $5 million cyclotron at a small college which has only a couple of physicists on its staff. You can give the two physicists a few thousand dollars for their research, but large expenditures must go to places that have staff and facilities for them.

(pp. 306, 310–311)

N. Distribution of Federal Research Funds Among Universities, Proposals for Wider

Concentration and distribution of Federal funds for research (Wilson)

There is concern about the heavy concentration of research funds in a few institutions and a few geographic areas, and a more broadly based distribution is advocated.

Institutions

* * * In 1962, 38 percent of all research sponsored by the Federal Government on university campuses was concentrated in 10 institutions . . . this concentration seems to me to have been inevitable. The Nation had many goals and commitments to be achieved quickly. Agencies responsible for reaching these goals had no choice but to turn to the institutions which had already demonstrated their competence. * * * The 10 institutions where 38 percent of the research activity was concentrated in 1962 were 25 years ago producing 42 percent of all the Ph. D. degrees awarded in the fields of mathematics, physics, and chemistry.

Geographic Areas

* * * In 1962 there were over 100 universities in this country conducting research for the Government at a rate of more than $1 million each annually. Of the top 100, 27 are in the Northeast, 29 in the Southeast, * * * 24 in the Midwest, 8 in the Southwest, 4 in the Mountain States and 8 on the west coast. That a broadening of the base is taking place is indicated by the fact that the proportion of Ph. D. degrees produced by the 10 institutions mentioned above has dropped from 42 to 31 percent. I doubt whether it could have been forecast prior to the war that in this short span of time 100 universities could be so strengthened as to be capable of launching, manning, and carrying through research programs of this magnitude. Their ability to do so has led to a concomitant ability to train young scholars.

Degree of balance

I am not suggesting that we have reached an ideal balance in this country; what I am suggesting is that * * * our quite legitimate concerns over imbalance should not obscure the substantial progress already made. The committee will doubtless wish to consider many of the programs now in existence or in the planning stage which are designed to bring even greater strength to institutions now at the threshold of high competence. * * *

The various traineeship, fellowship, general research support, institutional grants, science development, and other programs already launched or contemplated by various agencies, "all seem to me efforts to achieve more balanced strength in all regions of our Nation."

From time to time it is suggested that the quickest way to achieve this balance is simply to redistribute existing funds. * * * We have never in this Nation * * * accepted the concept of weakening the strong in order to strengthen the weak. I hope we never shall. * * *

(pp. 509–510)

Distribution of Federal research funds among the universities (Kirk)

The question is—should such funds be distributed more widely than they are at present?

The Federal research program is not really an "aid-to-education" program, but is rather an investment in our Nation's scientific future.

If this is the case, then there need be no apology for concentration of support for research in those institutions, public and private, where the quantity and quality of scholarly manpower is such as to give the greatest promise of productivity.

The present concentration of support has been necessary at a time when the urgency for progress is so great. When the existing "centers of excellence" have been sufficiently implemented, new centers can be developed.

(pp. 348–349, 354–355)

Distribution of Government R&D (Kistiakowsky)

An attempt to spread the Government's research activities more evenly among the majority of our 2,000 colleges and universities would lead to a "total collapse of scientific effort." To take care of shorter range needs and yet to prepare for longer range future it is essential to maintain the strength of the universities which are presently strong and at the same time to increase the number of strong institutions by a highly selective process. The cutting of funds for the National Science Foundation for fiscal 1964 by the House Appropriations Committee will stop an NSF program to help strengthen a few selected institutions which are genuinely ready to become strong and need only financial help to achieve it, and then to give them continued support.

(p. 611)

Imbalance in distribution of research support to educational institutions (Aderhold)

There are several unfavorable consequences of the policy of concentrating research support to those institutions which already have strong research programs and outstanding scientists:

(a) * * * a few strong, wealthy institutions have become stronger, wealthier, and larger in terms of funds and human resources.
(b) Developing programs attract other programs and funds, and other faculty and research men are drawn in from weaker and poorer institutions. In turn, better qualified graduate students are attracted.
(c) * * * economic growth and development slows in those areas not favored by Federal funds and speeds up in those areas which have been favored.
(d) * * * research and educational opportunities, already unequal in various parts of the country, are diminished because of the flow of Federal funds to a few institutions.

A careful appraisal of the effects of Federal research and development on the total educational and research needs of our country should be made. There should be a reexamination of the policy in certain Government agencies of offering grants on a geographic and State basis, and consideration of the application of this policy on a broader basis.

(pp. 904–905, 908)

Imbalance in support of higher education (Harris)

* * * are our programs of basic research and our programs of support of university and graduate education compatible with the long-term needs of the country?

At present these research programs are given to the institutions with greatest competence. "Unequivocal educational support" should be used to strengthen other institutions to help distribute national education and excellence.

(pp. 829, 833)

Lack of design in the development of national research program in the universities (Kerr)

The "Federal grant" university has developed in the past 20 years more by force of circumstances than by conscious design. It may be helpful to survey the current situation briefly as a preliminary to

making some suggestions about the future relationships of the Government and universities.

For about 20 years, Congress has been deciding in which general areas the Federal-university partnership should be developed. Decisions have not been made on the basis of thorough study of national priorities, but rather in pragmatic response to felt needs—atomic energy, national defense, health, and space, for example. Congress reacted quickly to each of these realities by authorizing programs of research.

As Congress authorized research, Federal research money went to institutions not "on the basis of any general review of institutional capacity or potential capacity" but on the basis of location of individual scientists who could do the job at hand. Most of these scientists were concentrated in a few institutions.

As the process has gone along, universities, accepting research centers and projects as proposed by faculty members and Government agencies, have made day-to-day piecemeal adjustments. They have reacted to situations, not made a studied response and as a result have been "profoundly affected."

Federal research money has been heavily concentrated in relatively few institutions. In one recent year 6 universities received 57 percent of the funds given for project research and research centers.

Twenty institutions now make up the primary group of Federal grant universities. If project funds continue to increase, it will be possible and necessary to extend more of them to universities beyond those in this primary group.

(pp. 1020–1022, 1023–1024, 1025)

Maintenance of a healthy relationship between the Federal Government and the universities. (Wiesner)

It is of special concern that the cut in the NSF budget and the no-new-starts policy required by the House will hurt one of the most important interests * * * that is, the effort to expand the geographical distribution of centers of excellence with all the economic and intellectual progress that this effort promises.

The NSF's proposed new science development grants program to strengthen nuclei of quality scientific faculties, and programs for undergraduate equipment and for graduate and undergraduate facilities, and the institutional grants program will be severely hampered.

Institutions must be identified which have high-quality potential all around the Nation. These institutions must take steps to develop themselves, in which process Federal assistance should be forthcoming.

The importance of maintaining a healthy relationship between the Federal Government and the universities must be emphasized. In addition to its unique capability to conduct basic research, the university is the resource for producing increased scientific and engineering manpower for Federal programs.

The Government must insure that its sponsorship of science does not corrupt the educational process by distorting its balance, values, and objectives. This requires as a minimum that the Government remain alert to meeting the full and fair costs to the universities of their own involvement in Federal activities, so as not to cause diversion of limited university resources from the educational functions to carry out federally sponsored programs.

* * * Based on extensive studies by the NSF and my office, this limitation [limitations of overhead to 20 percent in the grant authority of several agencies] should be removed in order to avoid severe distortions in the programs of colleges and universities. * * * I hope you will give particular attention to this problem during your study.

* * * I think that we have imposed in some instances much too strict control on the use of some of the research funds.

* * * We need to face how to rationalize these vast expenditures that go into the universities so that there is a more uniform treatment of schools.

(pp. 258, 265–266, 287–289)

Need for Federal assistance to develop additional top quality graduate institutions (Aderhold)

Although the States have become more conscious of their obligation for higher education and have redoubled their efforts, they cannot alone develop the additional top quality graduate institutions which the country needs.

To develop these top quality institutions,

* * * we must have a partnership with the Federal Government, and apportionment of research funds is one way in which this partnership can be developed.

(pp. 906–907, 908)

Need for investigation of method and philosophy of awarding contracts and grants (Rose)

It is suggested that the committee appoint a task force to study the methods and philosophy by which Federal agencies award contracts and grants to educational institutions.

The basic criterion for judging research proposals made to Federal agencies—the scientific quality of the experimenter—is questionable in terms of the overall national interest.

This method, which results in the distribution of contracts and grants to 25 institutions which receive 59 percent of all Federal research funds, is questionable. Approximately 2,000 colleges and universities receive relatively little Federal money. Academic and student talent tend to become centered in a few areas and a few institutions, adversely affecting others.

(pp. 792–793, 793–794)

Need to strengthen higher education throughout the country (Killian)

High-quality education needs to be spread throughout the Nation. There has been a concentration of effort in strong institutions and this has been, and still is, a sound policy; but the Government should now have a policy of building strong new centers of education through use of research grants.

More first-rate graduate centers are needed, and they should be better distributed throughout the country. Both liberal arts colleges and universities should be helped. This is not done by building on weakness, but rather by identifying those institutions which have shown the initiative and mobilized the support to strengthen themselves.

(p. 755)

O. Smaller Universities and Colleges, Effects of Federal Research Support

Effects of Federal research aid on other than first-rank universities (Kerr)

Federal research has concentrated in a few universities best equipped to handle it, because they possess adequate advanced training and facilities. This has strengthened their facilities and faculties, but may have hurt the second- and third-rank institutions by drawing away potential faculty to carry out the research in the first-rank institutions. "The good are better; the poor may well be worse."

(p. 1022)

Effects of Government research policies on small universities (Baldwin)

Less than 10 percent of the 2,000 institutions of higher education receive more than 90 percent of the funds distributed by the Federal Government, and almost none of this amount goes to small universities. This reflects the policy to give funds to those best equipped to conduct research, and, in general, it produces the best direct benefit to the public in terms of research results. However, it has a side effect which is not in the public interest.

This adverse side effect is that, while current policies increase the capabilities of the favored institutions, they have the reverse effect on the small universities. Teachers in the small universities do not have adequate opportunity for research, and good teachers are attracted to the favored institutions and to industry.

Two alternatives suggest themselves:

One is to offset the advantages to the top institutions by supporting the small ones. This smacks of charity, and would not be in keeping with the spirit of most small universities.

The other is to give all institutions of higher education the same opportunity, and this would be more satisfying and workable.

*** * * It could be accomplished by increasing tax deductions or by giving tax credits in sufficient amount to encourage private and corporate donors to support research and faculty development in universities.**

Administrators of small colleges have considerable experience in soliciting funds. In this respect, at least, they would suffer no disadvantage, and a climate of free competitive negotiation would be established.

It is my belief that both the educational institutions and potential donors would make this plan work without slowing the pace of research, indeed the number of individuals and institutions developing higher standards of excellence in research and teaching should markedly increase.

(pp. 379–380)

Manpower emigration from small colleges (Levin)

A complaint heard from small colleges is that they are unable to keep good research people. Once they develop a reputation, these people tend to want to go to a center where they can come in contact with other people of like interests.

(p. 601)

Support for research in small colleges and independent research units (Ewalt and Baldwin)

One of the most serious problems is how to deal with the smaller colleges and independent research units. It is important to support these so that they may attract and train personnel. Otherwise there is a vicious circle in which the schools cannot attract adequate Federal funds for research because they do not have enough trained personnel, and they cannot attract and train the personnel because of insufficient funds. While the problem of obtaining funds for research is difficult in a State university, it is impossible at a private, nonprofit institution. It is in the public interest to have a healthy mixture of research and teaching in the institutions of learning.

(pp. 367, 370, 379–380)

P. Geographical Distribution of Federal Research Funds

Geographic distribution of research funds (Bailey)

Wide geographic distribution of research support in land-grant colleges has demonstrated a highly successful record in agricultural research, and might wisely encourage the further allocation of research funds on a geographical basis in other areas of research. Some part of development funds should also be distributed geographically.

* * * there are in many universities * * * faculty members with outstanding competence, who, when provided with even modest support for research and development activities, will meet the challenge and produce not only things of practical, tangible value but also provide a much better education for their students in the process.

(pp. 874–875)

Geographical distribution of Federal research funds (Fawcett)

During the legislative process establishing the National Science Foundation, the Association [of State Universities and Land-Grant Colleges] vigorously supported attempts to get a provision calling for a geographical distribution to the States of a portion—perhaps 25 percent—of the funds made available to the Foundation. We based that attempt on the tremendous record made by agricultural research through just such a mechanism. That attempt failed, as you know. We strongly feel that experience with the grant-contract-fellowship system provides still another demonstration of the merit of this suggestion for partial geographical distribution of research funds, and hope that this committee will give it serious consideration and study in its deliberations.

(p. 999)

Geographical distribution of funds for general purposes of higher education (Levin)

The distribution of support for the general purposes of higher education, to universities throughout the country on a geographical basis, is desirable. However, this money should not be attributed to research, but rather to support of higher education.

We would like to have a little more help from the Federal Government in this total sort of overall support, because what one has to be very careful of is that, if one is worrying only about science and expanding science, this can take away from all the other fields of the institution, and get a very unbalanced and uneven institution.

I think that our fate in this country depends not only on science but it depends on strong institutions of higher education, because the future of our people, the development of their capabilities and capacities, depends directly on this. I consider institutions of higher education one of our most precious resources. Therefore, we should not weaken some aspects while we are strengthening others.

(pp. 599, 602)

Geographical distribution of research funds (Seitz)

It is difficult to decide whether or not geography should play a role in distributing research funds. Some say no; others say that if they are not so distributed good scientific work will be restricted to certain regions of the country to the impairment of national scientific strength.

The primary consideration for distributing funds is that they be spent on good work, wherever located. Some reasonable attention should be given to geographical consideration.

The National Institutes of Health and the National Science Foundation have shown "reasonable wisdom" in supporting centers of strength throughout the country, wherever they exist.

(pp. 62–63)

Q. Centers of Excellence, Establishment of New

Action to broaden the scientific community in the universities (Dickey)

More awards should be made to young scientists seeking to establish themselves. Federal assistance to research scientists has tended to be heavily concentrated in established centers and in grants to established scientists.

* * * The future health of scientific activity will require a considerable broadening of the scientific community throughout our colleges and universities.

(p. 1076)

Additional centers of excellence in the field of high energy physics (Levin)

Existing centers with facilities for research in high energy physics are sometimes overcrowded, and may be located at a considerable distance from some of the persons desiring to do research in that field.

It may well be you need new ones. * * * I can imagine in some parts of the country where people who wish to work on high energy physics it would be very desirable to have an appropriate accelerator closer by so they don't have to travel all the way to Brookhaven, Los Alamos or Berkeley, or wherever they are located.

(p. 600)

Effects of uniform distribution of research funds (Levin)

Centers of excellence cannot be established by just spreading money around to all the institutions or all the geographical areas of the country.

I think this is the shotgun approach and you might hit some, but you would miss a great many others.

A better way would be to establish a program such as the National Science Foundation has proposed.

> Let centers of excellence or places which desire to be such centers of excellence come forward and compete. Let them pick out those which seem most promising, and let them support the start of these things.

(pp. 598–599)

Establishment of new centers of academic strength (Kerr)

In an effort to build new centers of academic strength the Government will have to select institutions on the basis of their "general health." This will be a notable departure from historical practice, except in the field of agriculture. The ability to perform a specific project, especially in space and defense, is very important and has historically been the basis on which Government grants have been made.

In choosing an institution to support as such, not on a project basis, it is difficult to determine how such an institution will be chosen, how its merits will be assessed, and how to withdraw support from an institution if its performance is not good.

Selection of designated "centers of strength" assumes a single source of designation—a single overall Federal agency or committee. This means a single source of control, as against the current pluralistic situation.

> * * * a single source of control would turn an influential relationship between the Government and the universities into a really "perilous partnership."

(pp. 1023–1024)

Factors other than finances essential to establishment of centers of excellence (Levin)

A college has to have a will to become a center of excellence in research, and this may involve a change in the educational philosophy of the institution. It then has to take the action required to develop and, very important, to continue to support a center of excellence. This involves a large commitment for the future, and all the support cannot be gotten from the Federal Government.

> * * * I would guess that it would not be to the advantage of the Nation to convert any major proportion of our liberal arts colleges to research establishments. I think they are doing a wonderful job, and that we might in some way exert some deleterious effects upon that job if we convert them to large research or technological institutions.

(pp. 597–598)

Factors producing the development of centers of excellence (Wiesner)

Several factors are responsible for the development of existing centers of excellence and technological growth. These include:

> the presence of outstanding scientific schools and faculties, Government-sponsored research activities, a supply of skilled manpower, a diversified supporting industry, readily available venture capital, good transportation, and pleasant living conditions.
>
> * * * similar background conditions exist in other areas around the country where they can be catalyzed by the presence of high-quality institutions for research and graduate education in science and technology. Although the Federal Government can assist in the strengthening of these institutions, the communities themselves must accept the basic responsibility for their development, support and encouragement.

There are identifiable industries in certain areas which have the potential to become important to the area (for example, textiles, building, transportation, and coal). There is a need to create research centers to provide technical support to such industries.

* * * The Government can in a variety of ways illuminate the basis of choice through facilitating the availability of pertinent technical information; by promoting closer relations between industry and university faculties in science and engineering; by the support of studies of potential technological contributions to selected industry; sectors of especial national interest; and through selective support of research and development, basic to the growth of industries.

(pp. 265–267)

The financing of development of centers of excellence (Levin)

Centers of excellence cannot be created through giving a few research grants to an institution where there are not many people who wish to do research and who are of high quality. Centers of excellence cannot be established through the research project system that now exists. To do this, seed money, for a nucleus staff and for a facility for these people to work in is necessary.

* * * The one thing that is lacking today in all our research programs sponsored by the Federal Government is this kind of hard seed money to start centers of excellence wherever they may be appropriate, in whatever part of the country.

I was very saddened by the fact that the House Appropriations Committee cut out of the budget request of the National Science Foundation this year an item of $33 million which was exactly for this purpose, to start centers of excellence at universities and colleges around the country which have a will and a desire.

(pp. 595–596)

VI. BASIC RESEARCH AND DISTINCTION BETWEEN VARIOUS TYPES OF R. & D.

A. Commentaries on various aspects of basic research
B. Distinction between various types of R. & D.
C. Basic research in particular Government agencies

A. Commentaries on Various Aspects of Basic Research

Basic research as a preliminary to applied research (Bush)

As has been said many times you cannot have great advances in applied research unless you have as a basis an extensive body of fundamental knowledge, developed over years by basic research.

We once leaned on Europe for our basic research, but we are now doing better. But we should lead in every important field of fundamental scientific knowledge.

(pp. 461, 464–465)

Criteria for evaluation of support for basic research program (Hollomon)

Does the research add to knowledge at the rate and to the extent that we need to go forward and at a level we can afford? Is the research conducted with reasonable efficiency by people with adequate competence? Are we strengthening the Nation's institutions of learning? Are we creating the climate that will permit the eccentric genius, the maverick, to make his unique and valuable contributions to knowledge?

(pp. 291, 296)

Funds diverted from basic research (Seitz)

The basic research of the typical independent scientist is in danger of being curtailed through diversion of funds to more expensive scientific spectaculars. There is tendency toward such diversion in the present session of the Congress.

(p. 60)

Government role in research (Smith)

There is an area within which governmental support can be of maximum benefit to the public. This is the field of basic research. * * *

* * * * * * *

Thus, the Government is the proper institution with both the mission and the resources for large-scale support of the most basic research.

(pp. 1039, 1040)

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Maintenance and control of an adequate level of basic research (Getting)

By its nature research is decentralized, and incompatible with bureaucratic control, because research follows opportunity and circumstances and is highly individualistic. Basic research is an inalienable characteristic of a successful institution—a Government agency, a university, or a private company, and control should be at the lowest level practicable.

Under no circumstances should procedures, rules, regulations, or laws be enacted which place the control of basic research either in one Government agency, or even within Government agencies in one person or group of people. * * * Complete centralization in the Federal Government would pose all the dangers of a dictatorship.

Steps by the Federal Government to sponsor basic research in healthy and diverse ways taken in the past are (1) substantial grants to universities; (2) Air Force budgets for basic research in its major in-house laboratories under the local control of the civilian laboratory director; (3) Armed Services Procurement Regulation XV modification to allow costs of a company's independent research in a cost-type contract, provided the scope and amount are reasonable.

I would urge that Congress, in its traditional role, among many, of watchdog, scrutinize carefully the administration of Federal funds in support of research to make sure that the conditions for successful basic research are being enhanced.

(pp. 1011, 1012)

Nature of basic research projects (Wilson)

The research projects of basic research scientists are frequently regarded as absurd because they promise no definite application to a national goal or current question, but "it is not only easy to ridicule what we do not understand, but also perilous."

* * * It seems to me that it is the obligation of the scientific community, of the agencies which sponsor scientific research, and of the universities where this research takes place to find better ways of explaining their work to our citizens and their elected representatives. * * * If one of the outcomes of this study on which this committee is now engaged should be an underlining of the need for better communication between the scientific and lay worlds, it will be an important contribution.

(pp. 507–508)

Need for basic research (Seitz)

Development programs are often too costly or are failures because of a lack of requisite basic fundamental research. The success of national technology depends in a highly critical way upon sound systematic basic research.

(pp. 57–58)

Review of basic research by scientists (Waterman)

Any review of a basic research program should depend primarily upon the advice of leaders of basic research. The consideration of prospective programs must be largely a subjective process, depending as it does upon the judgment of experienced individuals.

(p. 812)

Unpredictability of usefulness of basic research (Waterman)

Because the results of basic research cannot be predicted, there is no way to evaluate their possible "usefulness." Atomic energy and radar are cited as illustrations of engineering developments which "had their origins in research so basic that it would never have been attempted as applied research, much less financed."

These two familiar examples precisely illustrate my first point; namely, that capital discoveries almost invariably have their origins in basic research, but which, since it explores the unknown, cannot foretell its findings, much less whether they will ever be practical. Consequently the idea that one should only undertake basic research which is sure to be useful is a most shortsighted policy and, as a rule, will miss entirely the outstanding advances which science may make possible. I had thought we had learned this lesson, but it seems we have not.

(pp. 808, 816–817)

B. Distinction Between Various Types of R. & D.

Analysis of the components of the Government budget for R. & D. (Schairer)

(*a*) Need to distinguish between basic research, applied research, and development, and to determine the division of Government spending between these three areas.

(*b*) Need to distinguish between development costs and production costs in military weapons.

I suspect that possibly half the quoted growth of development costs comes from changing definitions and not from a real growth.

(*c*) Need to distinguish between projects directed primarily toward Government consumption such as military weapons and projects of purely public interest such as those of the National Institutes of Health.

(*d*) Need to distinguish between research activities in furtherance of scientific objectives and those activities directed toward improving education in the United States.

(p. 1035)

Analysis of components of national budget for R. & D. (Waterman)

The large and rapidly increasing part of the Federal budget expended for R. & D. should be examined with great care.

* * * we should know what it is that we are examining and for what purposes the funds are to be used.

It is necessary to distinguish between expenditures for basic research "which alone is directed toward strictly scientific objectives" and is the only portion "which carries out the scientists' own programs," and expenditures for developmental programs which go for items "directly useful in the national and the public interest." Basic research expenditures represent only 10 percent of the national R. & D. budget; development expenditures account for 70 percent.

(pp. 809, 816, 817)

Balance between basic and applied research (Denney)

One question which should be explored is the balance between basic and applied research. Each is indispensable to the other. Basic research answers the question how things work, while applied research answers the question how to do a specific job.

> Are we sophisticated enough to realize that it is not a joke to say that basic research which knows what it is looking for is not basic but applied research? Is there danger that we are tending toward a poor balance between the two, as, for example, by drawing too much into applied research the academic resources on which we need to rely for basic support for research in international affairs?

(pp. 184–185, 194)

Complication of evaluation and classification of research programs due to vast range of activities and projects termed "research" (Haughton)

> Under current Federal definitions, the entire cost of testing a new missile such as Polaris, including the evaluation of all its components and the many checks which are necessary to insure its reliability, are all included in the research and development category.
>
> * * * The committee should realize that work on a major system of this type requires a different type of scientific and engineering personnel, different facilities, and generally higher levels of expenditure than the research work which is devoted to initial exploration of a new concept.
>
> Major systems development such as Polaris are * * * not instantaneously set in motion as full-scale programs. Neither we nor our customer agencies in the Department of Defense or the National Aeronautics and Space Administration would be willing to invest an effort of this magnitude without considerable assurance of success. And it is important to realize that this assurance in large degree comes from the multitude of smaller exploratory research programs * * *
>
> * * * * * * *
>
> To sum up, while recognizing the great diversity of activities which are currently included under the $14.9 billion dollar Federal research program, I believe that the committee can evaluate these as an orderly procession from the dawn of a basic research concept to its final application as a valuable asset to our defense posture, our national prestige, or our industrial well-being.

(pp. 100–102)

Confusion in use of terms "scientific research" and "basic research" (Waterman)

The indiscriminate use of "scientific research" and "basic research", and reference to national expenditures for research and development as expenditures for science or research leads to the mistaken impression that the terms are synonymous, and that all the expenditures go to scientists for their research in science.

> It does no such thing. Almost 90 percent * * * goes to Government and industrial laboratories whose mission is the development of useful equipment and devices for production. * * * Only 10 percent is for basic research, which alone is directed toward strictly scientific objectives. It is only this portion which carries out the scientists' own programs.

The distinction between "science" and "development and technology" is important because the two fields have to be handled differently. They are different in motive and in results so therefore they should be reviewed and studied from different points of view.

(pp. 809, 815–816)

Definition of applied science and its relationship to pure science (Teller)

* * * The activity when you work towards a reasonably clear defined goal, and a goal which is motivated by a practical application, but where this goal is not yet proven, you don't know whether it is feasible, and if it is feasible, you don't know whether you will ever want to spend the big money that is needed to put it into practice.

The study of the general question of turbulent motion is pure science, and when I apply that to weather prediction it is applied science. The applied science we are doing now is based on pure science. If pure science does not develop, then in the course of time but not immediately, applied science will wither as well.

(pp. 949–950)

Definition of terms defining areas of R. & D. (Bachman)

The committee should prepare a glossary of terms defining areas of research and development.

* * * We suggest * * * that at the start, definitions be prepared for (1) basic research, (2) applied research, (3) pilot plant research, and (4) prototype research. If other definitions are required in the glossary of terms, they could be added.

Granted that under these circumstances some of the definitions may be arbitrary, they may, if clearly expressed, serve as a common language base. If we understand the terms in which we talk, I think it will be easier to determine how much we spend on various types of research. You may well find that by far the major portion of our money is going for prototype or pilot plant efforts and far lesser amounts for basic or applied research. Information of this type should be helpful in your considerations.

(pp. 777–778)

Definition of various activities usually included under R. & D. (Collbohm)

There is a broad range of activities ranging from basic research through development and engineering. A full understanding of the variety of these activities, and careful examination of their specific nature, is important. Each really calls for different treatment from the administrative or policy point of view. [The witness' testimony included discussion of basic research, exploratory development, and system development.]

(p. 723)

Distinction between basic research, and applied research and development (Seaborg)

Although the two types of research overlap, there are certain distinctions. Among these are (1) motivation behind the research, and (2) the criteria that are applied to determine what work shall be undertaken and what changes shall be made in the lines of investigation as the study develops.

(1) Motivation

* * * In basic research the motivating force is not utilitarian goals, but a search for a deeper understanding of the universe and of the phenomena within it. * * * the underlying, motivating force in basic research is intellectual curiosity * * *

(2) Determination of how basic a research program is

If the final goal is very precisely stated, the program is probably not too basic. If the investigator is not free to make radical changes in his program and to pursue some unexpected question which has arisen in his work and which excites his curiosity as to why or how, the program is probably not basic. * * *

(pp. 66–67)

Distinction between "research" and "development" (Calkins)

Distinction should be made between "research" and "development" to avoid confusion and misunderstanding, and each should be considered and evaluated separately, each according to its own costs and benefits.

(p. 911)

Identification and definition of Federal research expenditures (Peyton)

* * * the chamber recommends that every effort be made to identify amounts being spent for actual research as well as those for development, testing, evaluation, and for support activities such as facilities and equipment, commonly called R. & D. plant. The statement frequently made that $15 billion is now being spent annually on research gives an erroneous impression. Only a small portion of this amount is actually committed to research. A relatively large amount is spent on development, testing and construction of facilities as well as purchase of equipment which should not be identified as "research."

* * * * * * *

It is suggested that the select committee not only provide definitive information on research expenditures and programs but that it also recommend that budget requests submitted by Federal departments and agencies be in sufficient detail to enable Congress to identify and evaluate these items easily.

(pp. 1032–1033)

Importance of understanding difference between research and development (Haworth)

(A member of the committee asked the witness: "If you had any single recommendation that you would make to this committee with respect to these programs you are talking about, what would it be?")

* * * I think the most important thing * * * (is) that we really understand this distinction between research and development. * * *

Research is a search for knowledge * * * development, on the other hand, is to do some particular thing for some particular purpose, and in general has limited application. Therefore, we must think of these not as a single package, but we must think of research in the broad sense.

We must think of development as something where we want to attain particular ends, and we must look hard at those particular ends, and especially so because development is the thing that costs the big money.

And so where we must be very, very sure of what we are doing from the Government's standpoint is that the developments we are supporting are worthwhile developments for worthwhile ends, and being well done.

On the other hand, in research we need the broad spectrum of knowledge, and we sitting here in Washington can't possibly direct research. We can support it. We can have some influence on where emphasis is in the sense that we may feel that some particular part of the whole spectrum needs more support than it is getting. We can do that sort of thing, but we can't possibly direct it or make real detailed decisions about it.

But in Washington we can make detailed decisions about whether we are going to develop this gadget for military applications or that power reactor for civilian application, and so forth.

(p. 51)

Need for better understanding of various types of research (Bailey)

Distinctions need to be made to the Congress and the general public about the different types of activities called "research." Definitions of, and distinctions between, "basic" and "applied" research and "development" (within certain limitations, of course) would mark progress toward communication in stating and evaluating long-range objectives of Federal research and development.

(pp. 871–872)

Need to define "basic research" and "applied research" (Waterman)

Two reasons support the need to distinguish between basic research and applied research:

(1) * * * basic research is true pioneering, and unless it is given completely free rein, it may miss important contributions to knowledge, many of which, as history shows, pave the way for sensational technological progress.

(2) * * * applied research drives out basic—a sort of Gresham's law. That is to say, under budget limitations and pressures to achieve high-priority, practical objectives, preference tends to be given to those items which are aimed directly at meeting practical needs. My concern at the moment, and it is a deep one, is that we are now observing a verification of this law in the critical attitude which is developing toward provision of funds for the support of scientific activities.

(p. 812)

Separation of expenditures for basic and applied science (Weinberg)

Only expenditures for basic scientific research should be part of the science budget. Expenditures for applied scientific effort should be considered part of the budget of whatever the application is meant for.

It is as improper to single out the military's expenditures for applied science as it is to single out the military's expenditure for transportation or communication.

(pp. 317–318)

C. Basic Research in Particular Government Agencies

Allowance of basic research as an item of costs in contracts with private agencies (Thomas)

Some of the Federal agencies which are concerned with development of hardware by their contracting proceedings discount the value of basic research. Some contracting procedures will refuse to allow basic science going on within an institution as an item of cost, which is shortsighted.

(pp. 413–414)

New vs. old agencies in basic research (Seitz)

The rate of scientific growth in the United States since the end of World War II has depended too much on the new agencies. Older agencies, with the notable exceptions of the National Science Foundation and the National Institutes of Health, have cut back basic research and focused energies on programmatic investigations. The Atomic Energy Commission is also an exception, since its support of basic research has retained a broad base throughout its history. National Aeronautics and Space Administration has not yet given support to basic science. It would be very desirable if NASA should devote 5 percent of its budget to basic research.

(p. 62)

Place of basic research in the space program (Webb)

Questions raised were (1) whether National Aeronautics and Space Administration has given sufficiently broad support to the basic sciences, and (2) whether NASA has incurred losses because developmental work has been attempted without having done some of the work in basic research that should have preceded it.

Neither charge is supported by facts. In contrast with other kinds of research, space research requirements are unique. Space research cannot be done in a laboratory. Therefore some developmental work must precede the basic research.

> You have got to have a rocket to get out into space, to leave the earth, and you have got to consider many measurements at the same time, so you relate the measurements in what they call exploration science.
>
> But now the point is that until the technology for flying rockets is developed, you cannot go out to do the science. We have had to spend a lot of money in technology in order to get to the position of doing science.

Between 5 and 10 percent of the NASA budget is at present devoted to basic research, depending on whether cost of tools needed to do the research is considered part of basic research expense.

(pp. 88–91)

Proportion of basic research in Department of Agriculture programs (Shaw)

More than one-third of research funds expended—both within the USDA and at State experiment stations—is for basic research, as compared with about 20 percent 5 years ago. (The Department's total appropriation for research is $168,716,000, of which $38,000,000 are Federal grants to State experiment stations.)

Substantial progress has been made, but a still greater share of our resources should go into fundamental work.

(p. 207)

VII. RESEARCH IN THE SOCIAL SCIENCES, THE BEHAVIORAL SCIENCES, AND THE HUMANITIES

Adequacy of private support of basic research in social sciences (Calkins)

Private support for basic research is inadequate. Private philanthropic money is often spent in the same areas as Government money, and the neglected areas are being covered only little better by private philanthropy than by public support.

(p. 913)

Adequacy of support for R. & D. pertaining to life, social, and behavorial systems (Calhoun)

Paralleling the achievements resulting from attention to physical and earth sciences and their applications, there has been less than necessary support to research and development pertaining to life, social, and behavioral systems. If programs in the aquatic, wildlife, recreational, and human sides of resource development are to achieve the maximum benefits of modern science and its sophisticated application, there must be continued assessment of the balance of research among these fields. A better balance which probably means increased support for research in the future is one of the desired objectives of Interior's program. At the moment we do no research on human behavior. It is my belief that there are some of the behavioral sciences on which research should be done if the missions of Interior are to be properly discharged.

And when I use "behavior" I meant behavior in the broad sense of the behavior of all life, and this includes fish as well as people.

(pp. 119, 122, 123)

Adequacy of support for social sciences and humanities (Haworth)

My concern * * * is not that there is too much research in the universities in the natural sciences, but that the other disciplines in the universities are falling behind, because they don't have equivalent sources of support, and that we have got to do something to do the equivalent thing from some source for the social sciences and the humanities and things of that sort.

(p. 50)

Adequacy of support for the social sciences relative to the physical sciences (Wirtz)

We are not doing enough in the social sciences.

There is just a startling contrast between the amount of research effort that goes into the physical science programs of this Government on the one hand and what goes into the human science or social science parts of it on the other. It is an ominous difference, I think.

* * * When I compare the amount of attention we are paying to scientific research with the amount of attention we are paying to human research—what we are doing right now is flying the most powerful jet engine in the history of mankind, and I mean to include all of our scientific and technological developments, and we are flying it by the seat of our pants, we are flying it by luck, by instinct, without any instruments at all in the cockpit. That is about the relationship

between the amount of research we are doing in the social sciences with what is being done in the physical sciences. And that is about where we are.

I am not sure that on this basis we are going to be able to keep our social engineers flying this blind with the amount of technological development which is being brought about.

We may or we may not be able to handle as self-governing social engineers what we know as scientists. A concern about "planning" sometimes inhibits research in the social science areas.

(pp. 156, 160)

Balance between research in the social sciences and other types of research (Denney)

There is the problem of the balance among different kinds of research for different agencies. With fragmentation of responsibility between agencies in the executive and between committees of Congress, with certain agencies related to particular committees, there is a tendency for programs "to grow up somewhat uncoordinated."

The claims of scientific and military programs are clearer and more dramatic, and doubtless greater, than the claims of other programs, but are they all that much greater? There is reason to doubt that questions of balance—say between programs of so-called hardware research and social science research—have ever adequately been examined.

The committee might want to question whether the social sciences should be given the low priority present figures indicate, and to change it, not by decreasing funds in the physical and life sciences, but by increasing them in the social sciences, and to explore the total "mix" of Government research.

(pp. 184, 193)

Disparity between the Federal expenditures on social science research and physical science research; the research activities of the Department of Labor (Wirtz)

The Department of Labor's total expenditure for research in fiscal 1963 was one-eighth of 1 percent of total research expenditures in fiscal 1963 by the Federal Government. The amount in dollars in fiscal 1963 was $5.4 million and is being increased in fiscal 1964 to $7.5 million.

The Department of Labor is a very small Department; its research program is very small.

In the Labor Department, the great bulk of research is "applied," though such a precise demarcation in the social sciences is difficult. Actually, the collection of general-purpose data accounts for a much larger part of the Department's work than "research," mainly because it is the primary source of basic economic statistics, such as the consumer price index, unemployment figures, productivity, etc.

We are relatively satisfied with the research program which we have in the Department. We realize that it only starts into the area of possibility as far as research is concerned. We will be wanting to do a good deal more with it. It is essential to an understanding of what we are about. * * *

In the field of the administration of the programs for which we have responsibility, there is a large need for trying to find out those things which are going on, which are not obvious on the surface, and which some analysis shows.

I hope that there will be more that we can do in the future about this program.

(pp. 155, 157–158, 158–159, 166–167)

Effect of Federal support of science upon the social sciences and the humanities in the universities (Kirk)

The charge is made that the flow of funds into scientific fields has created a distortion of imbalance within the universities because the social sciences and the humanities have received too little support, relatively speaking.

This may appear to be true but we must temper our judgment with certain other facts which are pertinent in this connection. The first is that financial needs for research in science and the humanities are vastly different. Except in the field of pure theoretical speculation, no one can carry on effective scientific research without a great array of costly equipment. * * *

Conversely, in the humanities, what, for example, does a professor need for his research? He must have some time free from teaching, an assistant, travel funds and access to a first-rate research library. In financial terms, with full allowance for the expenditures that such a library requires, the cost is relatively slight.

Moreover, because of the availability of Federal funds for scientific research, provided its costs are met in full for each project deemed worthy of Government support, the university can concentrate its own limited free funds to a greater degree upon nonscientific research fields. Also, the availability of Federal funds for science has enabled many of the great foundations to direct more support to other fields of scholarly interest. I do not say that the humanities have all the research money they need today; I do say that their relative need is small and that to meet it in full would require further expenditures on a scale quite modest compared with the costs of doing the same for science.

(pp. 341–342, 351, 356–357)

Factors inhibiting research in the social sciences (Wirtz)

(1) Concern in various quarters that it is "planning" and not research.

* * * the minute we start going very far into research in our field, somebody begins to wonder whether we are doing too much planning. Sometimes when we are simply trying to find out what we think we need to know, we find ourselves getting into an area in which there is concern expressed as to whether we are planning things.

(2) The unreliability and the dangers of the present incomplete mastery of a kind of research that relies so largely on making statistics out of people.

There is a very real realization on the part of the various departments of Government, realization of the imperfections of the research techniques which we have been able to develop so far. We realize by and large most of our research is reducing people to statistics and are drawing conclusions from that, and that is a pretty dangerous process, and not one that we are about to jump into too fast.

(3) Detailed public scrutiny surrounds the Government's efforts in the field of human resources research, probably because more people assume that these areas are more comprehensible to them than are the technical areas.

* * * By and large, the research done has been the subject of project-by-project appropriation, which has meant intense review within the executive branch and the Congress.

* * * We have learned to engage in elaborate consultation before starting anything new, not only with other scientists, but with community groups who are affected by the subject matter of our research. * * *

(4) No major human resource research effort based upon widespread participation by private and university researchers throughout the Nation has ever been undertaken.

But we have not in any sense developed the major network of cooperative activity of this kind which should underline our national efforts to cope with our human resources problems and the pressing issues of how to adjust to change brought about by technology and science.

(5) There is a deficiency of trained, knowledgeable, and expert researchers in this field in the universities.

This results in part from the shift in emphasis in the universities to the natural and physical sciences.

(6)

The committee may want to consider whether it would advance work in the field of human resources research if researchers in this field were to be given broader responsibilities in carrying out their missions.

(7) The finances put into the efforts of human relations study groups are small. The Manpower Development and Training Act has put somewhat more in this area, but the total amount is still small. Present authorizations for expenditure on the part of the Federal Government, even when supplemented by State appropriations and Foundation grants, have not created a major national research capability in the universities. Yet the universities should be a major source of ideas, experimentation, imagination, and exploration in depth.

I would hope that the committee might explore * * * ways by which we might bring this about. * * *

(pp. 156, 157, 161, 162)

Federal support of basic research in the social sciences (Calkins)

There is danger of concentrating R. & D. efforts on special programs in defense, atomic energy, space, medicine, and the natural sciences, and overlooking needs "that are not apparent and immediately related to current programs, but which for the longer run may become both urgent and critical."

In practice there has been little conscious effort to strike a rational balance between natural science research and social science research. This is a serious flaw in the present Government effort. Neglect of social sciences may result in much future "social distress" if we are unprepared for the changes brought about by scientific and technological revolution.

Only 2 percent of Government research money goes to the social sciences, which

* * * acknowledges neither what expanding knowledge in the social sciences has contributed to public policy in recent decades, nor what it will be called upon to contribute in the future.

* * * * * * * *

* * * The basic research that still needs to be done to permit an understanding of our social system, its operation and its malfunctioning, is very great, but the benefits to be expected from such knowledge justify an expanded effort.

* * * * * * * *

* * * Though the present research effort reflects certain urgent national interests, it does not adequately reflect our present or future need for knowledge concerning the operation of our economic, political, and social system, or concerning the problems of social adjustment that increasingly will have to be faced over the next generation. Therefore the question of balancing the Federal research effort is a fundamental one for this committee.

(pp. 911–912)

Imbalance in Federal research support among the sciences and the humanities (Aderhold)

The bulk of Federal research support is going to the physical sciences and engineering, while the life sciences, psychological and social sciences, and the humanities, receive much smaller amounts. Emphasis on the physical sciences and engineering has resulted in the buildup of those areas at educational institutions, while the social sciences and humanities have "stood still or shrunk."

I do not propose that Federal research and development funds be equally divided among all these fields. But, I would point to indications today that we need far more knowledge of the life sciences, the psychological and social sciences, and humanities, than we now have to cope with an already complex life. Tomorrow, that need may be expected to become intensified.

While this imbalance might be overlooked in a period of crisis, "to ignore it now would be to court disaster in the future."

(pp. 903–904, 908)

Need for money for research in social sciences and humanities (Rose)

It is suggested that the committee examine what is involved in increasing funds for research in social sciences and humanities. This is a great need, because only the social sciences can provide knowledge to cope with our perplexing socio-economic-political problems.

Scientists and engineers need wide training in the social sciences and humanities, and increased support for these areas is required even for "a reasonable technological program."

(p. 793)

Priority of funds for behavioral sciences (Weinberg)

[The low priority for funds for behavioral science was defended during questioning on the ground that]

compared to a science like physics or a science like biology, the behavioral sciences, dealing as they do with much more complicated situations, have greater difficulty in formulating their programs, demonstrating that they know exactly in which direction to spend large sums of money.

(p. 330)

VIII. RESEARCH IN MEDICINE AND RELATED FIELDS

A. Medical research
B. Pharmaceutical research
C. Optometric research

A. Medical Research

Adequacy of funds for medical research (Rusk)

Funds for medical research are insufficient generally, although in some areas like cancer research there are exceptions. Shortage of funds has held back research in some areas, but admittedly there are other causes of lag.

(pp. 495–496)

Bases for Government expenditures for health research (Feldmann)

Appropriations for health research should be based only in part upon the need for the research results. They should also be based upon the facilities and qualified scientists available to implement such programs.

(pp. 881, 885–886)

The effect of the medical research program on the supply of practicing physicians (Berson)

The question has been raised concerning the diversion from medical practice to medical research. Only about 5 percent of each graduating class goes into research, which is necessary for the future of medicine. We need more doctors for all activities, but it would be wrong to think that the way to increase the number of practicing physicians is discouragement of the present 5 percent who go into medical research.

(p. 804)

Effects of Government aid to research on nongovernmental aid (Rusk)

In the field of health research, Government aid has stimulated private aid in some instances, and in other cases the latter has tended to dry up. It takes both kinds of money because the activities they support are very different, and they complement and supplement each other.

(pp. 494, 499–500)

Federal financing of medical research (Blasingame)

* * * * * * *

The house of delegates of the American Medical Association at its clinical session in November 1962 adopted a report of the AMA Council on Medical Service which said that Federal research expenditures are a matter of continuing and growing concern. The council report referred to an earlier adopted policy of the association which acknowledged that "the mounting problem of proper allocation of Federal funds for medical research be given particular attention by the American Medical Association." The house of delegates directed the association to be watchful of Federal research appropriations and to offer to the congressional committees at the appropriate times the comments of the AMA.

Accordingly, aware of its responsibility in this area, the AMA Board of Trustees has recently appointed a special committee to consider the subject of Federal financing of medical research. Representatives of the association's council on medical education, council on medical service and council on legislative activities will meet with the board of trustees' committee on scientific activities on December 20, 1963. It is intended that the special committee will continue to meet from time to time until a comprehensive report may be made to the AMA Board of Trustees. The knowledge and understanding acquired by the AMA committee should enable the association to present expert opinion on the subject of Federal support of medical research.

We trust that at some later date we will have the opportunity of expressing our further views to the House Select Committee to Investigate Research Programs. Certainly, the effort of your committee and the review being conducted should prove helpful to the Nation. We would like to aid that effort in every way that we can.

(pp. 959–960)

Federal support for hospital construction and medical research (Berson)

Expenditures by the Government in support of these two programs represent investments in the health of the Nation which pay rich dividends, as has been amply documented. It is imperative that these programs be continued and developed further.

(pp. 795, 797)

Federal support for provision of teaching facilities (Berson)

The policy of the Federal Government in providing major support programs for medical facilities and medical research has complicated the conduct of medical education because of failure to include support for teaching facilities as well.

The three components of medical education—teaching, research, and service—are inseparable, leading to the concept of the medical center in which the three are united.

The new legislation authorizing Federal aid to medical schools and loans to students will be an enormous help when it becomes effective.

(pp. 795, 805–807)

Medical education and personnel (Rusk)

Medical research has generally been receiving more funds than medical education. Help for the latter is greatly needed, because there is a shortage of physicians in the country and probably will continue to be. The number of physicians is just about keeping up with the population.

Especially in the therapeutic fields, with its ancillary services, there is a need for professionally skilled people.

(pp. 496–497, 501)

Payments of full costs on Federal grants and contracts for the support of medical research and research training (Berson)

The Association (of American Medical Colleges) continues to recommend that grants from the National Institutes of Health for the support of research and research training permit the payment of full cost based upon a formula that will allow for variations in the costs from institution to institution.

* * * * * * *

(The association also recommends that) as a result of constant study each year's appropriation for research and research training continue to be adjusted to the national need, to the availability of the facilities and scientific personnel, and to the amounts of money that can be spent wisely and efficiently.

* * * * * * *

I think the time has come for the Congress to adopt as a basic policy the principle that each research grant and contract going to medical schools and universities bear the full cost of the research it now supports in part.

(During questioning it was brought out that costs of research in universities average about 29 percent. Medical research is in a more unfavorable position than physical research because the usual mechanism for assistance is a grant with a fixed allowable cost while in physical research assistance is commonly obtained through the contract which provides for the research and full costs of doing it as well.)

(pp. 795–796, 797–798, 801–802)

The relative contributions to medical research from the universities, Government laboratories, and private industry (Berson)

* * * As I see the situation, I can't really say that the Federal dollar buys more from the intramural programs of the NIH, for example, or from that supported in universities. I think they are both very important.

The Federal dollar gets good value through expenditure in the NIH intramural program.

* * * It could be overdone. I do not think that it is overdone at the present time. You could have too big an intramural program.

Some kinds of research can be done in the independent research laboratory or in the university.

If you consider the short-range aspects, I don't see much difference in the value that you get for the dollar.

The problems developed in research relating to a clinical application must be done in a medical center setting.

But if you consider the longer range dividends, I think that a byproduct of the Federal support of research in a university medical school may, in the long run, turn out to be even more important than the immediate direct problem. What I mean is that the research program enriches the academic environment. * * * the national byproduct is a continuing supply of young men competent to carry on this kind of research in the future.

(pp. 802–803)

The research grant for basic medical research (Berson)

A research contract is most useful when specific pathways to the solution of a research problem are evident,

* * * but this is rarely the case when attacking the fundamental problems with which medical faculties are concerned. It is through research grants, rather than contracts, that most Federal funds for the support of research in medical schools are provided.

The importance of the research program, as it has evolved under the leadership and guidance of the NIH [National Institutes of Health], cannot be overemphasized.

During the period of rapid growth in the national research effort the U.S. Public Health Service and the National Science Foundation—

* * * have made excellent, if uneven, progress in developing policies, procedures and staff to handle this complex matter effectively and wisely without interfering with the legitimate prerogatives and objectives of the institutions and the scientific community. The universities and medical schools have developed capability for the prudent management of grant funds and the full discharge of the responsibilities a research grant places upon them.

(pp. 797, 800)

Timelag from research to medical practice (Rusk)

Much improvement is needed in getting information of research discoveries from the laboratory to medical practice. The timelag is sometimes 12 to 18 months.

(pp. 494–495)

Training of medical personnel (Smith)

The training of teachers and research personnel in the medical field should receive "highest priority."

(p. 1040)

B. Pharmaceutical Research

Division of Government-supported pharmaceutical research between industry and universities (Feldmann)

Applied research should be carried out primarily by industry, secondarily by universities.

Basic research should be carried out primarily by universities and secondarily by the Government as needed to supplement university research.

It is most effective and efficient to have university researchers engaged in basic research, and industrial researchers in applied research.

(pp. 879–880, 884–885, 896–901)

Role of Government in pharmaceutical research (Feldmann)

In the pharmaceutical field, Government support should, in general, be limited to basic research.

It is appropriate for Government to support basic research into the fundamental principles of disease and illness, and into the fundamental mechanism of drug action. It is not wise for Government to get involved in the applied research of developing new drugs; in drug screening, except where necessary to enforcement of the law; or where an activity is too large for private industry to undertake alone.

* * * it is less wise for the Government * * * to materially or significantly participate in these [applied research] areas, because there is great need for additional basic research. If we have the industry, Government, and universities

all concentrating in the areas of applied research, we are fearful that the necessary basic research on which tomorrow's applied research will be built will eventually dry up.

(pp. 879–880, 884–885, 887)

C. Optometric Research

Recognition of optometry as a field of medical science entitled to Federal support (Jones of HEW)

[In reply to questioning concerning the current unavailability of Federal research grants to optometrists, the witness stated:]

* * * I don't think the research grant programs have been detrimental to the interests of optometry.

There are other areas in which relationships similar to those between medicine and optometry are matters of sensitivity.

(pp. 558–561)

Research in optometry, or the problem of control of research by the medical profession (Ewalt)

Members of the optometry profession have found it difficult to obtain funds for research, and as a result there is a shortage of personnel holding Ph. D. degrees in physiological optics, on whom research and the training of teachers is dependent. The difficulty of obtaining research funds has been hampered by resolution No. 77 passed by the American Medical Association in 1955 which declared that it is—

unethical for any doctor of medicine to teach in any school or college of optometry, or to lecture to any optometric organization or to contribute scientific material to the optometric literature, or in any way to impart technical medical knowledge to nonmedical practitioners.

For example, one research request was turned down on the grounds that the work was not to be done under medical supervision, yet this requirement could not be met because of the AMA's resolution.

Optometry's research program has been hampered because all too frequently we are denied access to Federal funds. Members of the medical profession, for all practical purposes, control the funds and are bound by the AMA resolution. This is another case of conflict of interest.

If the schools and colleges of optometry are to make their maximum possible contributions, they must have Government contract research and research grants. Congress should specify that certain amounts of the appropriations for research should be allocated to optometric institutions. This would attract students interested in scientific research in the field of vision. To correct the situation, which also existed for dental research until the founding of the National Dental Institute under the National Institutes of Health, Congress should establish a National Optometric Institute as a division of NIH, or some other agency responsible for research needs of optometry. It should be staffed by psychologists, physiologists, biophysicists, pathologists, neuropsychiatrists, and others as well as optometrists.

(pp. 365–367, 368–370, 377, 379)

IX. RESEARCH IN SPECIFIC AREAS

A. Economic Problems

Balance between military and civilian research (Biemiller)

* * * There are vast areas of our civilian life to which adequate research and development resources have not been applied because private incentives have been absent and Government policy has failed to compensate for their absence.

When private institutions fail to generate the research and development which the public interest demands, the Government must either increase private incentives or do the job itself. Because we have done neither adequately, very little is being done to improve urban redevelopment and transportation, to deal with the growing problem of air and water pollution, to speed up the vitally important program for the desalination of water, to assist small firms and sick industries and to raise the level of civilian life in countless other ways.

* * * Few things could enhance the image of America in the eyes of the rest of the world as much as an all-out attack on the problems of unemployment and poverty. And few things could contribute as much to the basic strength of America as the improvement of our human resources through greater expenditures on education and health.

(p. 958)

Development of collective bargaining solutions to problems (Biemiller)

We need to experiment with information and guidance services which can assist unions and employers, upon request, in developing collective bargaining solutions to the problems created by technological change.

(p. 958)

Justification for Federal expenditures on research in the problems of human resources (Wirtz)

The economist, the statistician, and the sociologist have often been the men whose research has created new national awareness or a change in attitude that has had the proportions of a social revolution that has strengthened our basic free institutions.

The entire concept of labor legislation grew out of early research into the living conditions of workers. The researchers who found a way to measure unemployment created a national determination to

do something about the problem, as legislated in the 1946 Employment Act. The researchers who figured out how to measure changes in prices created a reputable and scientific method of helping management and labor to adjust wages to changes in living costs. And so on.

Research work on employment and unemployment have brought to the fore several problems which must be dealt with and which presently remain unsolved: How shall we provide jobs for inadequately trained young people? How can minority groups share the general prosperity? How shall we meet the needs for vast amounts of education for the changing character of jobs in our economy? There are many others—and present research efforts in these areas barely scratch the surface.

Research, focused on these and other economic and social problems, could be an indispensable tool in finding answers to the shifting problems of the economy, its workers and managers.

(pp. 160–161)

Need for scientific study of employment and unemployment (Wirtz)

We have had unemployment now at over 5 percent for 6 years. It is taking on a whole new character because of technology, and it is centering on the unskilled and the untrained. Its concentration is of a very different nature than formerly when people were hit by it about equally all over the country. There is a necessity to find out more about exactly where the unemployed are and who they are, so that we will know something more about what to do about them.

The central question is to find out about what is happening to the idea of work in this country, how it is distributed, how it is concentrated, what its relationships to product are.

New indexes need to be developed. For example, there is some serious question as to whether we are measuring unemployment in the right way today. There are all kinds of analyses in this area that have got to be made in the future.

Our present research efforts barely scratch the surface of these problems.

(pp. 161, 163–165)

Problems arising from increased leisure time (Biemiller)

* * * we need to address ourselves to the host of problems arising from the more rapid increase in leisure time which is likely to occur within the next decade.

(p. 958)

Rehabilitation of distressed areas and regions; also advance preparation for technological changes (Biemiller)

We also need to find better ways of rehabilitating distressed areas and regions. And we need to develop an early warning system which can identify the kinds of technological changes likely to occur in the future; describe their effect upon employment; and facilitate the development of counselling, training, investment and other programs necessary to avoid human suffering and the disruption of entire communities.

(p. 958)

Relation of R. & D. expenditures to current national economic difficulties (Biemiller)

The current national economic difficulties can be attributed in part to an imbalance in spending for R. & D. The development of some areas has been encouraged while that of other areas of equal importance has been neglected.

More specifically,

> * * * American policy during the past decade * * * has shown a one-sided, almost single-minded, concern for the advancement of technology and productive efficiency while doing little to facilitate the difficult human adjustments made necessary by such advancement.

Various aspects of the problem can be summarized as follows:

(a) *Technological change has received more favorable treatment than persons adversely affected by it.*

While technological change has been encouraged by granting corporate income tax reductions, investment credits, accelerated depreciation allowances, subsidies and special tax treatment for research and development, equal attention has not been paid to protecting the victims of technological change.

(b) *There are widespread effects of spending for defense, atomic energy and space research activities.*

Federal spending for R. & D., although primarily for defense, atomic energy and space activities, has had influences reaching beyond these areas, for along with private expenditures for R. & D.,

> * * * they have created a revolution in our way of producing goods and services. They have created an era in which machines are replacing human judgment and performing incredible production miracles in almost every sector of our economy. Moreover, they have systematized and speeded up the whole process of discovery and technological change instead of leaving it to chance as in the past.

(c) *Rapid technological changes produce serious problems of human readjustment.*

When technological changes are slow and moderate, the problems created can be dealt with without undue hardship. But when they are far-reaching and rapid and when they occur in a period of slow economic growth, as has been the case, their effects are "extremely disruptive" and human readjustment is "exceedingly difficult." The result has been widespread unemployment and in some cases entire communities have been "left in a state of impoverishment."

(d) *No real effort has been made to balance the needs for physical and social science research.*

> This failure to put our technology to work properly is not an indication of our inability to cope with social problems; it is rather an indication of our unwillingness to devote adequate resources to their solution. We have made no real effort to balance our need for research in the physical sciences against our need for research in the social sciences.
>
> Other witnesses appearing before the committee have called attention to this glaring inadequacy.
>
> [Problem areas requiring further study were enumerated.]
>
> * * * * * * *
>
> In our view * * * the most significant problem in the area with which this committee is concerned is not the need for economizing on expenditures for research and development. It is rather the problem of devoting more research

and development resources to the solution of our great social and economic problems and the strengthening of civilian life in general.

(pp. 957–958)

B. Miscellaneous

Personnel situation in the field of socio-medical research (Rusk)

Problems of aging population will require a great deal of socio-medical research. The supply of personnel for this field is "terribly short." Research is only beginning in the vocational rehabilitation field because effort has been concentrated on training personnel in present knowledge, in order to meet the great demand throughout the country.

(pp. 497–498, 501)

Support of applied research in materials fields (Harris)

In the materials field *applied* research programs that contribute to systems development have received only minimum support. Sometimes pragmatic engineering approaches have been used to find solutions for problems that basic research has been unable to solve.

(pp. 830–831, 834)

Adequacy of research into water pollution problem (Representative Robert E. Jones, Jr.)

The analytical tools and scientific knowledge which served well for the problems of the past are proving increasingly inadequate in dealing with present pollution problems and will become more so with foreseeable future problems. Thus, water pollution research must develop an effective new science while those who administer the water pollution control programs attempt to hold the pollution line with available knowledge.

(p. 954)

Engineering and international assistance programs (Harris)

Consideration should be given to determine whether there has been established an effective relationship between engineering and the U.S. international assistance programs. Have we allocated sufficient funds for preinvestment research?

(pp. 829, 833)

Research on resource environments or environmental systems (Calhoun)

Perhaps the most critical research need that has developed in the entire field of natural resources is the need for research on understanding resource environments or environmental systems. * * * It is impossible to understand how to carry on operations within any system unless the system itself can be identified and described, and its performance characteristics measured. Although we have recognized the need for research in such broad environments as the atmosphere and ocean, we are now considering whether more attention is needed for * * * parks, Indian reservations, hydrological networks, or the crust of the earth.

Now, what I am trying to say is that in nature all of our resource systems can be viewed similarly, as an organism—not a living organism, certainly, but as an organized system. And it is fundamental to our evaluation of these systems and to our statement of policies to effect their healthful existence, to have a

knowledge of the system as such—what they are made up of, why they exist, how they function, what their parameters are.

I think in the whole natural resources area this is our most critical need.

(pp. 121, 126)

National Science Foundation's policy toward research in political science (Kirkpatrick)

The National Science Foundation, created by Act of Congress on May 10, 1950, provides research grants and fellowships in psychology, economics, anthropology, and sociology, but excludes political science completely from its fellowship program and virtually excludes it from its research grants and other support. Such exclusion by the National Science Foundation is without rational justification, has worked and is working an undue, unfair, and discriminatory hardship on political science as a discipline and a profession. Thus, the officers and Council of the American Political Science Association feel that this NSF policy is an appropriate subject for consideration by the Select Committee on Government Research, with particular reference to the question of the impact of Government research programs on the academic community.

The American Political Science Association, through letters and conversation, repeatedly has sought to get a change in NSF policy. It has had no success. A change of policy is essential, however, and is certainly one that is in the national interest.

* * * * * * * * * * *

* * * The remedy for the existing situation is simple enough. The NSF made the present policy; it can change it. NSF should (1) open its fellowship programs to political science on an equal basis with the other social sciences, particularly economics, psychology, anthropology, and sociology; and (2) establish a section for political science, staffed by political scientists, in the Division of the Social Sciences; it should be coordinate with those in economics, anthropology, and sociology. If these changes are made, political science will enjoy the same benefits from NSF as the other social sciences.

In closing, it should be noted that the National Research Council of the National Academy of Sciences has reorganized its Division of the Behavioral Sciences this year to include political science on an equal basis with the other social sciences. This sets an example that the NSF might well follow.

(pp. 1027, 1029–1030)

X. GOVERNMENT-INDUSTRY RELATIONSHIPS IN R. & D. ACTIVITIES

A. Government-industry relationships
B. Government contracts to industry
C. Patent policy
D. Byproducts of Government R. & D.

A. Government-Industry Relationships

Alleged superiority of large, over small, firms in pursuit of organized research (Foley)

It has long been argued that large firms are in a better position to pursue organized research activities than small firms. The most important reason given is sheer size because (1) only large firms can afford to maintain a number of research projects of which only a few will be successful, and small firms do not have this margin of safety; (2) small firms face shortage of personnel, have less access to outside funds, and are unfamiliar with business opportunities outside their own locale; and (3) economies obtainable in large-scale operations are not available to small firms, who cannot count on a diversity of research projects necessary if they are to exploit their discoveries to the utmost.

Although there are some elements of truth in this, the small firm can, and should, play a larger role in our total research effort. Small business has certain inherent advantages: (1) it is more flexible organizationally and in many cases can exploit development potentialities neglected by the larger firm; (2) in some of our most important industries innovations of major economic significance have come from independent inventors and small firms; (3) many major increases in productivity have come about through a series of small process and product changes, well within the capabilities of small business; and (4) small firms have been creators of a long list of the important commercial inventions of the past century. Even big business concedes the role of small business in invention and innovation. In short, small business can provide a meaningful contribution to our national research endeavor.

(pp. 733–734, 738–739, 743–745, 745–747)

Competition with foreign R. & D. efforts (Halaby)

In research on commercial aircraft, such as the supersonic transport, many foreign governments have no compunction about furnishing full subsidy for development, which they achieve through nationalized corporations. What is at stake is private enterprise in aeronautical manufacturing. To meet the challenge to the supremacy of the United States in the production and sale of commercial aircraft, the Presi-

dent has proposed a Government-industry partnership in which research and development costs are to be shared, and recovered by the Government and private industry as partners.

(pp. 133–136, 138–140)

Delineation of areas of R. & D. between the Federal Government and industry (Jones of Esso)

Federal research management should give more attention to the proper evaluation of research projects. Among the areas of Federal intervention in research that are questionable are those "which are not likely to be of commercial utility until 10 to 20 years hence or even longer," and in particular, "applied research and development oriented toward the civilian economy." Not only could private industry make use of the technical talent in programs which might benefit the economy in the more immediate future, there is also the danger that research programs with long-term objectives may be outdated by subsequent developments.

*** * * this select committee can, I believe, serve a very useful purpose by focusing attention on the need for careful delineation of those areas of research and development appropriate to Federal support, and those appropriate to industry support. Some of the management problems now confronting the Federal Government in research may be minimized if the areas of Federal Government responsibility for research are spelled out clearly.**

(pp. 781–782)

Distribution of Federal research assistance to economic and technical areas (Rose)

I suggest that the committee appoint a * * * task force which will devote its attention to the problem of redirecting our national research efforts to areas which will support economic and technical growth of the Nation as a whole—this to the extent permitted by the need for research in support of weapon and space development.

(p. 793)

Effects of Federal tax policy on industry's R. & D. (Vickers)

In our company [Sperry Rand Corp.] we are convinced that we must be able to invest adequately in basic and applied research, and that, to do so effectively, we must make a satisfactory profit after paying for our in-house research.

Federal policy respecting corporate taxation has a major effect on what funds remain available for research by industries, and a substantial reduction in corporation taxes and favorable new tax laws are looked forward to.

Your committee may wish to explore whether special tax allowances to encourage selected explorations by industry have merit, particularly in research areas that would advance important national objectives.

(p. 1066)

Effect of Government-supported research on industry (Bush)

In view of our economic difficulties—insufficient rate of industrial growth, excess outflow of gold, and international trading problems—

It would be well to find out whether the pressure of Government-supported research is not now preventing industry from doing its research job well.
(p. 462)

Government-industry relationship in large, mission-oriented projects (Vickers)

The closest relationships between Government and industry occur in the large, mission-oriented projects in which there comes into being—

an evolutionary mix of concurrent applied research, development and now, generally, small scale production. Such projects obviously consume the greatest share of Government-provided funds. It is here that understandable interest centers on choosing the right project to meet the specified objective, or of deciding whether duplicate projects should be undertaken to meet the same objective. Because of the high costs involved, critical choices must be made by Government not only on what hardware will do the job, but whether the objective itself is one of national necessity. And it is not infrequent that a more agonizing decision needs to be made, viz, when to stop a project that is not getting anywhere, is too costly, or too late.
(pp. 1066–1067)

Incentives for industrial research (Peyton)

An examination should be conducted into the means and incentives which governments at all levels can use to create the proper environment to stimulate private enterprise to do increased research.

Given the necessary incentives, the private sector of the economy will perform much of the research now being funded by the Government.
(p. 1034)

Joint responsibility of Government and private industry for certain programs (Hollomon)

Here I think recently we have come into the most trouble. Like Dr. Wiesner, I am convinced that we are inadequately supporting those things that have to do with our civil side of our life and our technology and our economy. But in these cases we must insure that we do this, if the Federal Government participates, without taking away the initiative of the private enterprise.

When the technology applies to a general activity that benefits the whole of the public, or is so costly that individual support is not feasible or sufficient, or when its benefits are too diffuse to warrant individual support alone, then Government has a role to play.

Examples of these various situations are (1) agricultural research, (2) R. & D. in the communications satellite and supersonic transport programs, and (3) early support of atomic energy and aviation technology.

As technology matures, however, participation by private enterprise should expand. Questions then have to be asked as to the rate at which the Federal Government should withdraw from the support of the technology. Elimination of vested interests, or of technological featherbedding, or scientific featherbedding, is a problem not unlike that in private industry.

The "civilian industrial technology program" in the Department of Commerce is designed to catalyze the support of technology by industry and to examine those factors in the environment which retard the rapid use of technology for industrial development.

I am convinced that the benefit to the country as a whole as well as to private industry of an increased industrial technology effort far outweighs the private and public costs.

(pp. 292–293, 296–297)

Nature of relationship between Government and industry (Haber)

The Government-industry relationship should be considered as a partnership, rather than a competition, and improvements in this partnership should use the incentives inherent in the free-enterprise system.

(pp. 605–606, 608)

Relationship between Government agencies and civilian scientists (Murray)

The relationship between Government research officers and civilian scientists has changed in the past years, until now scientists solicit Government agency support more often than the agencies go to the scientists with research problems. This relationship warrants more consideration and recognition.

(p. 457)

Relationship of Government R. & D. to industry R. & D. (Killian)

Several problem areas can be distinguished in the relationship between Government and industry:

(1) What has been the effect on the utilization of scientists and engineers on the Federal R. & D. carried on by industry, and on industry's own privately financed R. & D.?

(2) Have the growth and policies of the Government's R. & D. program been a cause of the decrease in the rate of growth of R. & D. financed by industry?

(3) Has the Federal R. & D. program caused a rise in the cost of research so that industry has had to hold back its own research?

(4) R. & D., whether privately or federally supported, which is sponsored by industry is concentrated in a few industries. Can Government encourage industry in a wide utilization of research in industry?

(p. 758)

The relatively small proportion of Government R. & D. assigned to small business (Foley)

Small firms should have a larger role in the Government's R. & D. efforts. The portion of Federal R. & D. money received by small business is below its capabilities, and is an insignificant amount of the whole spent by the Federal Government on R. & D. A few large companies receive a high proportion of the research money. A 1960 survey by the National Science Foundation indicated that the largest firms, representing only 3 percent of the total, accounted for 90 percent of federally financed R. & D., while the small firms (those with less than 1,000 employees) representing 90 percent of the total number, accounted for only 5 percent of federally financed R. & D. Yet the small firms employed 10 percent of the available R. & D. scientists and engineers. Surely they are capable of obtaining a larger share of this work.

I am concerned about this statistic and I am confident that Congress shares my concern. My position is that small business has proven to be an efficient performer when it has had an opportunity to participate in prime contract awards. Its capability to perform in this area of Government expenditures is greater than the very minor role it has experienced. However, I fully realize that it is impractical for Government agencies involved in research and development activities to be bound with a mandate stating a fixed percentage be awarded to small business. That is beyond the limit that we would care to go. Such a mandate would only divert Government agencies with research responsibilities from their main objectives. It would neither be desirable for the economy nor good for the taxpayer. There are other avenues of approach. (This was followed by an explanation of the various methods used by the Small Business Administration to improve the position of small business.)

(pp. 739–741, 744)

The responsibility of private research in the national research effort (Jones of Esso)

In summary, we would like to urge that the committee give careful consideration to the desirability of making the national research and development effort more efficient and effective by stimulating and encouraging private enterprise to take on the responsibility and expense of a larger portion of the total national research effort for the benefit of the national economy. Such an approach will place the responsibility for research and development on those parts of our American system which are in the best position to exercise this responsibility.

(p. 784)

Use of private industry for Government research. (Vickers)

* * * We feel that your committee might want to consider whether present Government-industry relationships on basic and much applied research tends to discourage industry from "selling" its scientific capabilities to the Government. Many industrial research directors find themselves "locked out", believing that such advanced research sponsored by the Government is the exclusive province of the Government laboratory, the university or the tax-exempt institution. Others are hesitant to mount a complex marketing task to seek out potential business from myriad agencies, to expend the time of their most valuable research workers in the risks and frustrations of current bidding procedures, and to compete against agencies or universities which appear to have a built-in competitive advantage.

The use of broad area, support-type contracts with reasonable overhead allowances deserves serious consideration. Industry is quite capable of supplying a greater share of advanced research to Government, provided means of funding this research are improved.

(p. 1066)

B. Government Contracts to Industry

The bidding process in letting Government contracts for performance of research by private industry (Vickers)

One aspect of large-scale defense projects which is worthy of consideration is the extensive investment by industry in the competitive bidding process involved in selecting one or more contractors for a development assignment. Competitive bidding of this type

* * * is a high-risk situation, and winners and losers of contracts alike are making multi-million-dollar expenditures each year. Much of this cost is borne by industry. * * * Since only the winner may profit, the other contenders have suffered a dilution of profit. We feel that more efficient means of procurement should be encouraged.

(p. 1067)

The concept of profits in negotiated contracts between Government and industry (Vickers)

The Department of Defense merits commendation for its new regulation, ASPR 3–808. It greatly expands the principles involved in the negotiation of profits and fees on negotiated contracts. Briefly, it gives contractors opportunity to earn profits commensurate with risk, increases rewards for good performance records, and rewards contractors who provide their own facilities and financing or who have made prior pertinent contributions in R. & D. at their own risks.

If this regulation is administered throughout the contracting process in the spirit expressed in this policy [ASPR 3–808.1 policy], it will most assuredly be in the national interest. * * *

We should point out, however, that other modifications to procurement policies are needed also. * * * Profits obtained from Government contracts become progressively lower as one goes from production to development to applied research to basic research—and frequently the latter two are done at a loss. We believe your committee will feel with us that this is not a satisfactory situation for either Government or industry.

Finally, there are objections to the present section XV of the Armed Services Procurement Regulations which, although it does not in itself seem unreasonable, has been unsatisfactory in application because it in fact makes cost sharing mandatory. The restrictive effect of mandatory cost sharing limits the potential benefits which industry could contribute to the economy. The committee might be interested in seeing a constructive outcome to the current attention being given to revising the regulations.

(pp. 1067–1068)

The cost of independent R. & D. as an overhead item in defense contracts (Haughton)

There are certain costs that are completely excluded from overhead. We cost share sometimes on the basis of it all comes out of profit, what we call share. It is a matter of negotiation with the agency that we are doing business with. In other instances the agencies that we do business with in the Government will allow a portion of the cost of this research to go into our overhead. Now this doesn't mean that we recover everything in overhead, because we have straight fixed price contracts, and we have fixed price incentive, and we have cost-plus incentive, and then we have in some of the R. & D. work, we have CPFF [cost plus fixed fee], so it goes across this wide range. But it means that part of the cost goes into the overhead and goes into the Government contract. Sometimes this costs the Government something. Other times it doesn't cost the Government anything.

In making a contract with the Government, the cost of research is added in as a part of the cost of services to the Government. It is not added on a profit basis but as a part of overhead.

[It was asked whether, if the cost of personnel salaries for research should run 10 to 20 percent above the average for the industry, that would be added in as part of the overhead. In reply the witness said:] "The cost of their salaries, yes." [When asked whether it did not matter how much these people doing research were paid, if the company wanted them for special jobs, because Uncle Sam would pick up the tab, there was this reply:]

Uncle Sam picks it up on certain kinds of contracts and certain kinds of contracts we pick it up on * * * a lot of these jobs that we win we bid them. * * *

we have more competitors than just in the aerospace industry now. * * * there are a lot of people doing work for the Government other than just the aerospace industry.

(pp. 104, 106–107)

Criteria other than size to be used in awarding contracts to "small businesses" (Foley)

R. & D. contracts should not be taken away from big firms merely to be given to small firms, nor should any definite percentage of contracts be reserved for small business.

The Small Business Administration has not attempted a geographical diversification of contracts to small business.

Other important factors, in addition to size, include the experience of the leading members of the firm, their financial competence, their previous relationships with either Government or industry in terms of success.

(pp. 747–749)

Disadvantage of small firms in contract negotiation (Foley)

Some smaller concerns do not take the trouble to bid on contracts, because they believe they have no chance to win—there is "just a complete feeling of frustration."

Small firms often have to hire outside help to aid them in the complicated processing of a bid for a Government contract, because the requirements are so complicated. Large concerns, however, can keep experts for negotiating purposes, at Government expense.

(p. 745)

Method of letting contracts to industry (Halaby)

There are certain principles which should be more widely applied in issuing contracts to industry. In development contracts, the private contractor should share the cost because he may share in the benefit. In some cases the Government should get a royalty on the products that evolve from the contractor's developmental work.

(p. 130)

Negative effects of small applied research contracts (Haber)

The small size and short duration of applied research contracts have the following effects upon an industrial research laboratory:

1. Compartmentalization of effort, which frustrates interaction and interdisciplinary activities.
2. Difficulty in attracting the best personnel, who tend to avoid such an atmosphere because of its instability.
3. Inefficient use of technical personnel on proposal writing and negotiations for small contracts.

Recognizing that many projects are small and isolated in nature, the present system has tended to fractionize research effort more than necessary. Wherever appropriate, the continuity of research efforts and extensions over longer periods of time should be encouraged.

(p. 607)

C. Patent Policy

Patent policy (Smith)

Government should develop a realistic patent policy, so planned and developed as to encourage cooperation between industry-supported researchers and Government-supported scientists.

Government contractors, even though using Government research money, should receive "fair and adequate exclusivity" for the results of their research work in recognition of the fact that they were chosen by the Government because of their "superior facilities, know-how and inventive genius." Such arrangements spur incentive for future work.

(pp. 1038, 1040)

Protection of private investment in products of private research (Vickers)

Laws involving acquisition without compensation of rights for the Government in data and inventions developed with private research funds, have brought an alarming reduction in protection of private investment in research.

Many of these laws, policies and practices not only discourage investment of private funds, but when such funds are committed, the cost and risk of the private research and development is increased. Congress has already heard much testimony to the effect that this situation is not in the best interest of the Government. We trust that this important aspect of the Government-industry relationship will be given attention by your committee.

(p. 1066)

Small business and patents and proprietary rights (Foley)

Small firms feel that they have been dealt with unfairly in the area of proprietary rights and patents.

Because of their small portion of Government-financed R. & D., small firms have less access to research byproducts. Prime contractors can more often obtain patents and processes which they can exploit commercially.

Congress made its intentions clear in section 9(b)(2) of the Small Business Act, with instructions to the Small Business Administration to assist small business concerns in obtaining such benefits.

(pp. 733, 741)

D. Byproducts of Government R. & D.

Corollary benefits of the Federal research programs (Haber)

The first of these is the technical contribution that defense, space, and atomic energy programs have made to industrial activities and consumer products. * * *

(There is) another legacy of perhaps equal importance, This is the ability, on the part of the Government-industry team, to manage and complete very large projects of extreme technical complexity. This capability is available for other future challenges that may be altogether outside the realm of atomic energy, defense, and space. * * *

Owing to the size and scope of these programs (several possible programs are cited), planning and financing would require Government participation. The skills and techniques to undertake such tasks already exist in the Government-industry partnership developed in the course of our defense, space, and atomic energy programs.

(p. 608)

Effectiveness of converting R. & D. into practical products (Vickers)

Research and development is viewed as a pyramid of four parts. At the top is basic research; the greater the incentive for the researcher to put his findings to use, the closer he approaches the next segment of the pyramid. The next segment is applied research, which carries forward the application of scientific principles toward ultimate production of useful results. The third segment is development, and the fourth section or base of the pyramid is production.

This, in our view, must be the paramount and ultimate goal of the whole research and development process. It is through the production and distribution of the fruits of research and engineering that each citizen—who in fact pays for the whole effort—receives the benefits for which he pays.

If the committee concurs with this premise, then the emphasis in its appraisal of Government's role in research and development should be upon how effective is the process of converting research and development into practical end products serving the Nation. Inasmuch as only industry is or should be exclusively involved in the functions of production, sale, and distribution, it is apparent that the interfaces between the four segments of the pyramid and thus also of the Government-industry relationship become of utmost importance.

(pp. 1064–1065)

Finding useful byproducts of R. & D. (Halaby)

More attention should be given to getting double duty out of development dollars by gleaning new products and byproducts of research. Just as in industry, in the various agencies there should be someone constantly watching for things that can be picked out of the research and development programs and made usable for civil applications.

(p. 131)

Relationship between the military and industry in use of results of defense R. & D. (Teller)

(A member of the committee questioned the witness concerning (1) the charge that too much time and attention are devoted to military R. & D. at the expense of the civilian economy; and in particular to (2) the charge that the military, under the guise of security requirements, do not release results of R. & D. for civilian use.)

I am under the impression that there has been a conscientious effort and an effort that has paid off to make available the results of our military research to our economy. One example is the development of our planes. * * *

I do not deny that there may have been cases where better, earlier availability would have been of help. But in general I think this charge is based on an exaggeration, I mean the charge that military developments are not available to the civilians. This is an exaggeration.

In one respect, however, the charge may be valid, but this is not due to action of the armed forces.

* * * We have laws, very restrictive laws, concerning security. In many areas you are not allowed to communicate to the industry unless it is first clearly and completely proven that publication cannot possibly hurt our country. Such proof is immensely hard to get.

* * * * * * *

I believe that at any rate the burden of proof should be on the other side. Things should be open, unless proved to be dangerous. * * * The willingness

for cooperation is there. The practice of cooperation is there. But some of our laws make the cooperation unnecessarily difficult.

(pp. 942–944, 951)

Usefulness of military and space R. & D. in the civilian economy (Foley)

Most Government R. & D. work is directed toward national defense. For the most part, the implications (the spillover) of military technology for civilian uses are largely unexplored. The Small Business Administration is conducting such explorations, and is working with the National Science Foundation, the National Aeronautics and Space Administration, and the Department of Commerce to supply small business concerns with usable information derived from Government-funded R. & D. The SBA is conducting several services for transmitting such information to small business.

It must be recognized that the knowledge gained from Government expenditures in space and military research and development can, in many cases, be transferred directly into industrial application. This information contains the potential for creating new industrial techniques, materials, products, and processes. If assimilated properly, it can exert a profound influence on our civilian technology. The Federal Government, therefore, has an obligation to develop a workable system of utilizing this enormous reservoir of scientific information so that its benefits can be transmitted to businessmen both large and small in order to provide the ingredients necessary for an accelerated growth in our civilian economy. * * *

(pp. 741–742)

XI. MANPOWER, SCIENTIFIC AND ENGINEERING

A. Allocation and utilization of manpower
B. Competition for manpower
C. Developing manpower
D. Scientific freedom
E. Shortage of manpower
F. Conflict of interest

A. Allocation and Utilization of Manpower

Allocation and utilization of limited scientific and engineering resources (Jones of Esso)

It is doubtful whether the fraction of national resources devoted to science and engineering can be increased "simply by making more money available", and it is questionable whether the greatly increased R. & D. effort now in the preliminary stages will yield benefits to the national welfare commensurate with its costs. More important than the expenditure of money is the proper allocation of the limited supply of scientific and engineering resources which is available. [The resources referred to are primarily "creative, imaginative, inventive, innovative people who spark the research and development programs."]

The Nation has in the last quarter-century developed a very large research and development capacity.

However, it is my opinion that we have not coupled research production with the rest of the civilian economy in a satisfactory manner. We are still learning how to plan and use research so that the results can be of the most timely value to the economy as a whole.

(pp. 781, 785)

Allocation of manpower to different areas of R. & D. (Haworth)

* * * Whereas funds for military research and development are equivalent to and, therefore, interchangeable with funds for other military purposes, the same is not true of our resources of scientific and engineering personnel. They are not interchangeable with production or military manpower and our total is limited in extent. We must, therefore, be careful not to overuse this resource in any single area to the serious detriment of others.

(pp. 12, 14, 20)

Brainpower waste (Brown)

An individual's talent may be wasted if he shifts around agencies and programs too frequently, or if he changes from one field of research in which he is very experienced to one in which he is less so. Changing from one to another program, however, is not necessarily wasteful unless it happens too often.

(pp. 181–182)

Impact of military and space R. & D. on civilian economy (Kistiakowsky)

Effect of use of major portion of our scientific and technical personnel on military and space problems:

(*a*) Partial responsibility for slow growth of the civilian economy, and

(*b*) Partial responsibility for inhibiting the growth of privately financed research and development because of the consequent rise in cost of R. & D.

(pp. 610–611)

Manpower utilization (Killian)

Proper manpower utilization is more important than the way we allot our R. & D. dollar. The Government should always consider manpower utilization in the advance planning of its large R. & D. programs. It should avoid policies and procedures leading to inefficient deployment of personnel, overemphasizing one area at the expense of another, stockpiling, and so on. Since 60 percent of all scientists and engineers in R. & D. in the United States are working wholly or in part on programs or projects financed by the Federal Government, the Government has a major responsibility in manpower utilization.

We urgently need more information about manpower utilization. At the request of the President, a committee sponsored by the National Academy of Sciences, of which I [Killian] serve as chairman, is studying the subject and hopes to report early in 1964.

(pp. 757, 762–763)

Misuse of scientific personnel (Bush)

*** * * I do not think there is any danger in the basic field of getting a good scientist to work on the wrong thing. * * * I know perfectly well you cannot get a basic scientist to work on anything unless he is genuinely interested. * * * He will pick his own problems if he is any good.**

The big engineering organizations have to be run in the way you would run any business, and there men get put on to things that they do not think worthwhile. It is bound to happen.

(p. 466)

Results of overexpenditures for research (Bush)

*** * * If the country pours enough money into research, it will inevitably support the trivial and the mediocre. The supply of scientific manpower is not unlimited.**

[In questioning, the belief was expressed that] we have already reached the point "where our support of research exceeds the supply of first-rank scientists."

(pp. 461, 463–464, 467)

B. Competition for Manpower

Alleged pirating of scientists from private industry by the Government research programs (Haughton)

In 1955 the divisions of the Lockheed Aircraft Corp. employed a total of 8,300 scientists, engineers, and supporting personnel in research and development work, representing about 17 percent of our total labor force. By 1962 this group of research and development employees had increased to 27,000, about one-third of our total labor force.

I don't think they [the Government programs] are pulling scientists from us. To be real honest and straight about that, we might be on the other side of that. We might be hiring scientists that would otherwise be employed in other industry. * * * However, I think there has been an increase in the recognition of scientists, and I think this will adjust itself as time goes on. But I guess we have done this with our programs. We have pulled scientists from other places, because we have increased our scientists.

[Replying to the question of overbidding for the services of scientists and technicians, the witness stated:]

I don't believe we pay more than the going rate in our industry.

(pp. 104, 105–106, 108–109)

Competition between Government and non-Government establishments for scientific personnel (Jones of HEW)

The present salary ceiling for scientific personnel in Government is too low to enable the Government to obtain the number and kind of scientists it needs.

As to NIH, its problems are related to a lack of competitive situation with even educational institutions now for the services of competent scientists who are available.

The salary ceiling of $20,000 is considerably below what is the going rate for competent medical scientists in most of our institutions, and certainly in our commercial research laboratories.

(pp. 553–554)

Competition for brainpower (Brown)

New agencies and programs frequently draw scientific talent away from other agencies and programs to the latter's detriment. This is a significant problem in some cases. Of course, if Congress changes the relative amount of research funds appropriated to the agencies, it expresses its judgment as to the relative importance of the programs, and resulting shifts of scientific personnel are inevitable.

(pp. 181–182)

Effects of Government research programs on manpower supply (Haworth)

* * * Certainly the work of the Government in defense and space and so forth has created a competition for scientists and engineers. * * * and certainly scientists and engineers are in some disciplines in short supply in total, and I think in most disciplines there is need for more highly qualified scientists and engineers.

* * * I don't think that one could say that Government research has pulled people away from industry any more than industry research has pulled people away from Government research. I think it is just a competition * * *.

(p. 49)

Increase in salaries of scientific personnel (Shaw)

The need to pay scientists salaries "that are commensurate with their worth" is a problem in the Agricultural Research Service. Passage of the 1962 Federal Salary Reform Act which removed the ceiling on supergrades for scientific positions in Government promises to help meet this need. This, coupled with the salary increases provided in 1962, has notably improved the situation. Federal salary legislation now pending before Congress will be of further assistance in competition for top quality scientists.

(p. 208)

Necessity of attracting the best minds to the public service (Wiesner)

Several studies have dealt with this problem. 1962 congressional action has helped the situation with respect to adequate salaries. However, there is a special problem that affects the salary of top executives. Reports have dealt with this particular aspect of the problem.

High quality, prudent and thrifty management will not follow automatically from wise legislation, careful appropriations, or even direct orders by the President. Implementation of Presidential and congressional intent ultimately rests on the shoulders of Federal staff. * * * I would urge that this Committee recognize the direct relationship of Federal staffing to the quality of science and technology programs with which your study is concerned.

(pp. 263–264)

Need for improved pay and personnel policies in Federal Government (Killian)

Inadequate Government pay scales and personnel policies make it difficult for Government to attract and keep technically competent administrators. Such personnel is necessary to improved Federal R. & D. programs. The committee should give special attention to ways whereby good management in the national R. & D. effort can be encouraged and recognized.

(pp. 757–758)

Salaries of scientific personnel (Bush)

With the greatly increased amount of Federal funds available for science, there is a danger that the competition for personnel will force salaries indefinitely upward, making it difficult for industry and nonprofit institutions who do not get Federal funds to compete.

(p. 462)

Waste of scientific personnel through competitive contracting (von Braun)

Competition among industrial teams for major space contracts ties up a lot of top talent making proposals and studies to put them in a good competitive position. Often these people do not carry through on implementation of the programs they proposed when a contract is secured, but start work drafting new proposals.

This competition is a very healthy thing because it brings the best ideas to the fore. It is highly desirable because it forces everyone to try to be a little better than the competitor.

(p. 532)

C. Developing Manpower

Basic research in advanced training of scientists and engineers (Waterman)

One final but no less important aspect of basic research is that it is an essential ingredient in the advanced training of scientists and engineers. Its natural habitat is the colleges and universities where these are trained and where the association of young inquisitive minds gives added impetus and effectiveness to the research performed.

(pp. 812, 817)

The competence of applied scientists (Teller)

Newly graduated scientists generally wish to engage professionally in pure research and teaching, and the newly graduated engineers are well trained for development work. Between the two, the education of applied scientists is neglected. In our few "very wonderful" applied science laboratories, the talented recruits from the universities have to be retrained for their jobs in the laboratory.

Why do I say this? Our universities train excellent specialists, mathematicians, physicists, chemists, but the chemist doesn't understand the mathematician. The mathematician doesn't understand the physicist, and sometimes I believe the physicist doesn't understand anybody.

We need people, we need specialists who can understand each other's language, who can cooperate, and we need particularly people with general education in the physical sciences, who can lead these cooperative efforts, which are characteristic of the great discoveries, the great inventions of the last few decades.

* * * It is my opinion that general research and development needs support, needs support which is criticized carefully and in detail, but perhaps what our national effort needs most is a decent supply of applied scientists who can take the wonderful insights of the pure scientist and turn them into practical applications. If this can be accomplished, then the United States will take first place in applied science. On this effort our future may depend in several important respects.

[The witness described a new course in applied science which he is developing at the University of California.]

(pp. 941–942, 946–949, 951)

Developing scientific manpower through aid to higher education (Harris)

The Federal Government can help to develop scientific manpower through direct educational grants and fellowships, as well as by basic research projects. Recent appropriations cuts in Congress "eliminated almost all of the exciting new proposals for graduate educational support. A suggested means of dealing with future programs of a similar purpose might be revealed by a case study to determine how such appropriations cuts have affected proposed graduate programs in engineering, mathematics, and physics.

(pp. 831, 836)

National manpower needs (Kerr)

The educational system is in most trouble at the bottom and at the top. At the bottom, occupational training, retraining, counseling, guidance, and relocation are needed to provide skills valuable in a dynamic economy where skill levels are rising at perhaps the fastest rate in history. Full employment is the necessary complement to make such training effective.

At the top, the Nation needs more research activity in a number of fields and more highly skilled personnel—particularly engineers, scientists, mathematicians, teachers, and medical doctors. The most recent Bureau of Labor Statistics survey shows that from now to 1970 the expected supply of engineers and scientists will fill only three-quarters of the demand. This is a very large gap. The prospective situation is particularly critical for engineers.

Fortunately, the levels where Federal aid is most necessary are levels where Congress has been most supportive.

(pp. 1024–1025)

Need for engineers of broader professional training (Haber)

Engineers' professional education does not include enough training in applied R. & D. translating formal knowledge into workable and economic products and systems. This should begin at the university level, rather than being delayed until the engineer's subsequent employment.

(p. 608)

Need for scientific talent to support increased R. & D. functions (Furnas)

The proportion of Federal R. & D. money relative to the gross national product (presently about 3 percent) cannot increase significantly in the future until the number of "top talent" scientists and engineers is increased through university education. The present level of Federal support does not constitute an undue proportion of the GNP, nor is it a great financial burden. Logically Federal R. & D. expenditures should continue to rise, but the proportion relative to the GNP is conditioned on production of scientific manpower.

(p. 1009)

Relationship between R. & D. needs for manpower and the general manpower situation (Calhoun)

* * * the role of research in our society is closely related to the development of creative people. Inasmuch as these cannot be separated it is necessary to consider research and development needs in parallel with manpower needs. Appropriations to one segment of research, by its existence alone, can draw manpower from another area of research. The possibility exists of placing natural resources research contracts with universities in such a manner as to achieve the maximum development of needed manpower for supplying the Federal research and management program in these fields. Interior's program has little flexibility for achieving such a goal at the present time.

(p. 120)

D. Scientific Freedom

Freedom of scientific investigation under Federal grants (Berson)

Immediately after World War II there was concern in the academic and scientific community that the freedom of individual investigators, and of the institutions in which they worked, might be so severely restricted by governmental regulation and supervision as to interfere seriously with the productiveness of scientific research. The policies of the National Institutes of Health have, however,

> * * * proved so farseeing and imaginative that this did not come to pass, and the scientific community soon achieved a sense of great confidence in the wisdom and soundness of the program. From the outset, the National Institutes of Health organized a system of close scientific and administrative supervision through their own staff and through study sections, as well as various councils.

(pp. 796, 799)

Improper use of scientific personnel by the Government (Thomas)

(The question was raised as to whether scientists employed by the Federal Government are properly utilized in terms of their qualifications.)

A scientist in Russia might have to do what he is told,

> But this being a free country, if a man makes a choice of doing something that he doesn't want to do, just because of the facts, where the money is or something like that, this is a free choice. I wouldn't respect the man as a scientist. I might respect his economic judgment, but, of course, that is as far as I would go.

Since the stated purpose of this committee is to see that Federal research money is well spent, there is a question whether giving scientists more freedom would, or would not, make our research activities more efficient and effective. The extent to which Government scientists do, or do not, have freedom in their work is of importance, particularly if by comparison with their degree of freedom in nongovernmental research.

(pp. 415–417)

Maintenance of balance between controls and scientific freedom (Jones of HEW)

A balance must be maintained between prudent expenditure of research funds and safeguarding of scientific freedom.

> Some scientists have expressed concern that these controls (designed to insure the prudent expenditure of research funds) may jeopardize the freedom of the research scientist essential for productive and creative scientific achievement. We are confident that this delicate balance between prudence and freedom will be appropriately safeguarded.

(pp. 539–540)

Scientific freedom (Heald)

> Finally, I think it cannot be overemphasized that the quality of research—especially research that leads to breakthroughs in knowledge and understanding—is vitally dependent on the freedom of the researcher.

The Ford Foundation has subsidized a study concerning the basic freedoms that a scientist needs in order to conduct effective research. It is being conducted by a committee of the National Academy of Science, under the chairmanship of Dr. Kistiakowsky.

(pp. 388, 404)

Scientific freedom (von Braun)

* * * I respectfully suggest that the paramount consideration is that our basic research efforts continue to move forward as swiftly as possible, without administrative obstruction, without bureaucratic delay. This can be done only if we assure to the scientist his freedom to pursue truth. * * *

Any corrective measures taken to improve research should not hamper scientific freedom, but nurture scientific talent. Pure science must be an open society, self-regulating, not regulated by any Federal control agency.

(p. 516)

E. Shortage of Manpower

Availability of scientific talent (Furnas)

The reservoir of scientific talent is being depleted more rapidly than it is being filled. This situation bears directly on some very serious problems of higher education.

(p. 1007)

Manpower shortage (Levin)

(In response to a question whether or not we had enough people trained to enter the teaching and research fields, if very large new centers were established, the response was in the negative.)

No, I think we are getting shorter and shorter and this is one of the great virtues of the Federal program of training. * * *

While there are some people today who are not doing all the research they could do now and who could use additional support, there is also a

* * * need to train more at an accelerated pace, in order to keep up with the times, or we are going to find ourselves in trouble along about 1975, or so.

(In response to a question whether it would be unwise to build additional research centers if people were not available to man them, the witness stated that by the time the facilities were available, the people for this purpose would be available.)

(pp. 600–601)

Need for brainpower (Brown)

More researchers must be trained. There is probably not enough trained manpower to develop more research programs. In the long run research has always repaid the effort that is put into it.

(p. 181)

Need for graduate-level engineers (Killian)

The high priority assigned to basic research in the university does not mean that applied research is not important. For example, the National Science Foundation has recognized what might be called "basic engineering research" to be conducted in engineering schools.

It is urgent that United States increase the quality and quantity of engineers at the graduate level with training in research "which involves making things work."

(p. 755)

Need for scientific generalists (Collbohm)

Colleges need to develop more scientific generalists, able to apply a number of different disciplines to the solution of problems in order to improve the rate at which we progress. During the past few years there has been an increasing application of techniques, methods, and tools developed in one field of science, to others—what we call the interdisciplinary use of knowledge.

(p. 724)

Scarcity of highly trained manpower (Fisk)

Quality in this type of manpower is of the highest importance. Much fine work has been devoted by the National Science Foundation to encouraging an awareness of and a respect for quality in both scholarship and teaching. It may well turn out that quality—as well as the scope—of our scientific and engineering teaching is one of the prime national resources possessed by our country.

It is difficult to find personnel who are able to work in the zone between engineering and the sciences at a sufficiently high level of skill.

Bell Laboratories find it necessary to require that the newly hired college graduate with bachelor's degree in engineering complete a graduate program, at the company's expense, leading normally to a master's degree or higher.

(pp. 1002–1003)

Scientific manpower (Harris)

One of the important issues which the committee should consider relates to scientific manpower.

To what extent are we limited by manpower in the research and development that we can carry on; what are the resources of competent individuals who can be retrained in order to be effective in research and development programs of great national urgency? It is as necessary that we not underestimate the national potential to do research as that we do not overcommit these critical manpower resources.

(pp. 828, 832)

Shortage of scientists (DuBridge)

There is no question there has been a great shortage of scientists and engineers in the last few years, and that there is competition between Government, industry, and universities in getting the best ones, but "healthy competition is a good thing in general."

All we have to be careful of is that we are not trying to get more research done than there are people to do it, and I don't think in the field of basic research we have yet reached that stage.

(p. 315)

Shortage of supporting help for professional scientific staff (Shaw)

Shortage of junior scientists, subprofessional help, and labor to assist senior scientists constitutes a problem to the Agricultural Research Service.

(p. 208)

F. Conflict of Interest

Conflict of interest as it affects review of R. & D. programs (Waterman)

In the selection and use of experienced and competent consultants and advisory committees, the problem of resolving conflict-of-interest issues is a "most perplexing" one.

In principle, conflict of interest must be scrupulously avoided, especially by the Government, for obvious reasons. However, when carried to its extreme, this means that no expert can qualify for consulting service if he is receiving any direct or indirect support from the Government for R. & D. projects or programs which relate to his consulting. Since in carrying out the R. & D. programs which the Government supports it is obviously important to secure the services of the ablest individuals in the field, rigorous application of this extreme policy means disqualification of this top group for consultation. Clearly this is an extremely grave matter. It is not soluble by asking such individuals to drop out of related activities. In the first place, many will refuse; in the second, if they accept, they are then lost to the programs involved. I have no good answer to this dilemma, except to say that such individuals are essential in both capacities, and that therefore one must select individuals with high integrity and objectivity, and count upon their performance accordingly.

(pp. 810–811, 820)

Evaluation of use of scientific advisory panels (Jones of HEW)

[The witness replied to a question from a member of the committee concerning alleged dangers in the use of outside advisory panels to make recommendations concerning research programs or contracts to be undertaken.]

This is not considered a problem in the case of the projects of the National Institutes of Health.

For example, if a council approves a project application under a NIH Institute, the Surgeon General is not obligated to approve that project as to its concept or as to the amount of money. The staff of NIH and of the Surgeon General are constantly reviewing these actions of the council. They participate with councils in these decisions, so that the Federal responsibility is recognized, even though recommendations are made by non-Federal advisory groups.

With respect to other programs within HEW, extensive reliance on the advisory panel system is "more difficult."

* * * For example, the Food and Drug Administration relies on advisory groups, and it will do so increasingly. But here we have a regulatory function, so that the conflict-of-interest problem enters into the picture much more extensively than would be true in the pure and basic science field where you are dealing with nonprofit public institutions almost exclusively.

Consequently additional factors have to be brought into account when one undertakes to utilize the same kind of mechanism. Different techniques are justified, relating to the specific needs of special programs.

There are procedural safeguards excluding an individual member from a council in consideration of a project from his own institution.

(pp. 551–552, 556)

Possibility of conflict of interest in advising Congress (Harris)

There is a possibility of conflict-of-interest situations arising with senior scientists and engineers in giving advice to the Congress, because most of them have been involved in Federal R. & D. programs. The Engineers Joint Council is a tax-exempt organization and the law restricts our activities in relation to legislative matters.

(pp. 829, 833)

XII. INFORMATION AND PUBLICATION

A. Information storage, retrieval, and sharing
B. Individual Government agencies
C. Scientific and technical publications

A. Information Storage, Retrieval, and Sharing

Availability of scientific information (Smith)

There should be improved scientific communication within the United States of the results of Federal research activity. All grantees and contractors should be required to submit yearly reports which should be made public unless national security or other confidential matters are involved.

These reports should be properly indexed by the Government and made available to any interested party. This is the only way in which the scientific community can be kept currently informed of research progress, since final publication of many results occurs even years after completion. Also, the publication of unsuccessful efforts would assist other researchers by preventing them from repeating the experiments.

(p. 1040)

Central register of research projects and grants (Kirk)

A central office is needed where all research projects and all grants in all fields would be registered to avoid duplication of activity, to let researchers and institutions know what others are doing, and to find areas where research is needed.

(pp. 348, 353–354, 360)

Communication between the scientific community and the public (Harrar)

There was a time when there was very little of such communication. The situation has gradually improved, but much remains to be accomplished toward greater mutual understanding, in part from greater R. & D. in the art of science administration. Certainly, science has the obligation to interpret its role to the public and to those responsible for furnishing support. Both the legislator and the administrator desire adequate communication.

(p. 1016)

Dissemination and distribution of scientific information (Representative Robert E. Jones, Jr.)

Significant savings could be made in this area. There is little use in the extensive research efforts of the Federal Government if the end

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products are not communicated in usable form to those to whom they could be useful.

* * * If information growing out of the multitude of Government research projects is unavailable because it is buried beneath thousands of other reports, then all the money and effort which went into the research has been wasted. The waste is more tragic because it results from nothing more than an inability to simply find the results of what has been already accomplished. This waste, in turn, can lead to further waste in the form of duplication and repetition of research which has already been accomplished.

To eliminate this wasteful situation the Government must maintain an effective internal communication system, and it must assure an effective over-all communication system. By "overall" I mean that the Government must assume responsibility even toward those parts of the non-Government research systems that do not overlap with its own, simply because Government has assumed such heavy responsibility in the entire research area. This means that the Government, in the very near future, must improve existing systems, and devise new ones where necessary, for preserving the valuable information growing out of its vast research program and rejecting what is worthless. It must take the responsibility for summarizing, indexing, abstracting and distributing its information promptly and efficiently.

I am sure this committee will want to devote considerable effort to this entire area of information distribution and retrieval. The opportunities for savings are great.

(pp. 955–956)

General availability of expensive research results (Thomas)

[The question was raised as to whether it is a form of waste to make expensive research results—particularly those pertaining to military use—available to the world scientific community. The witness replied:]

No, I do not. I will give you an example. Some figures I read recently pointed out that in the USSR, one farmer can feed three people. In the United States 1 farmer feeds 29 people. Agricultural science is the same all over the world. It is equally available to the Russians as it is to us.

I think the specific answer to your question is that the scientific information developed through research is available to everybody, and the question of who utilizes it best is the important element in the question that you ask, not the development of research, of science through research. This I never consider to be wasteful.

* * * * * * *

Of course, you have at the one extreme national security leaks, and at the other you have the fact that no matter what you develop, take the atomic bomb, for example, information about it is always bound to come out in the long run. * * * But this is an inevitable thing.

* * * I think we find a very good balance between the extremes of secrecy that would stifle scientific information exchange on the one hand, and too free and open an operation on the other.

* * * * * * *

You can't hold back human thinking, and this is what you are dealing with.

(pp. 417–418, 419)

Information retrieval (Haller)

The information we already have must be made easier to find and use. One of today's biggest problems in R. & D. is simply knowing what has been done.

Better methods are needed for storing and retrieving technical information we already have, and the Government might well support more research on the information retrieval problem. Better use should

be made of existing computer technology in cataloging and retrieval. Present communication between laboratories and scientists, through meetings, reports, and technical journals, is a stone-age approach to the problem. The amount of information now existing is so great that it can no longer be adequately transmitted by people talking and listening and writing to each other.

(pp. 333, 336, 338–339)

Need for improved communication in research (von Braun)

There is "urgent need" for "prompt, open, continuous communication" among scientists and between scientists and the Government hierarchy.

At present the means whereby a scientist-engineer can canvass research in his field are inadequate and may lead to duplication. It is sometimes easier to conduct research than to locate information on what others have done.

An organized, comprehensive data system is recommended whereby a scientist can obtain information quickly and accurately. High-speed electronic research-library and data-dissemination systems now being developed will be the greatest tangible improvement which can be made to the Government's research program at present.

We must improve the means whereby the scientist communicates with the administrator and through the administrator with the public.

We must find a way to inform the Congress, as representatives of the people, in layman's language, of scientific facts on which to base national research policy decisions. Providing such a service to the Congress is becoming one of the imperatives of our democratic system.

It is very important to the scientific community that the national standard data system in the National Bureau of Standards be fully implemented. Congressional financial support will be needed in future years.

Better use could be made by members of the scientific community and by administrators in the Government of NASA's system of bibliographical document control, and it could be copied in developing information handling systems in other scientific fields.

(pp. 518–522, 523)

B. Individual Government Agencies

Access by industries to information of National Science Foundation (Haworth)

[A member of the committee stated that he had been informed of some difficulty by segments of larger industries, claiming they did not have access to information of the NSF, whereas smaller concerns in industry had no difficulty whatsoever. He asked whether this had come to the witness' attention. He replied:]

No, and I don't see how it could be so.

[The member furnished the witness with a copy of the allegation and entered it in the record, with a request that the witness respond to it later.]

(p. 55)

Evaluation of work of the Scientific Information Exchange (Freeman)

Is the information given out by the SIE of good scientific quality, and do SIE services really inform research directors and scientists about new research that they may not have heard about?

The report of the President's Scientific Advisory Panel indicates that SIE services accomplish their primary purpose. Hundreds of unsolicited letters also say so. Five hundred users of SIE information were recently asked by questionnaire these questions, and 97 percent replied that they had learned about new research in their own specialties that they had not known about before, and the information helped them avoid duplication. Seventy percent said the SIE answers were comprehensive and did not contain extraneous or irrelevant material. About 50 percent said they used the information to avoid duplication in preparing research proposals and grant applications.

From this evidence, it would seem that this kind of an information service does, in fact, fulfill its primary purpose and that the information is judged to be of good scientific quality.

(pp. 844, 845)

Interchange of scientific information (Furnas)

Standardized methods for classifying, indexing and abstracting coupled with appropriate machine methods will facilitate communication of R. & D. information. These should be encouraged. The overall Scientific and Technical Program (STINFO) should be encouraged and stimulated.

(p. 1010)

Lack of scientific information facilities (Shaw)

Library facilities to meet increasing demands for scientific information are needed by scientists in the Department of Agriculture, State experiment stations, and industry, doing research on food, biology, and agriculture. An appropriation has been recommended for plans for a new building for the National Agricultural Library at the Agricultural Research Center in Beltsville, Md.

(p. 207)

Prevention of duplication in research by the Science Information Exchange (Freeman)

* * * In the present research process, there is probably a 1- to 3-year gap between the time that an investigator actually starts his work and the time the results are finished, published, and available to the general scientific community. It is the time that the research project is proposed and the time that the results finally appear in the technical journals, libraries and other documentation services. It is the SIE's purpose to complement these services by covering the prepublication hiatus of the research process. * * * timely information about new projects when they are started and long before they are generally known, can do much to help avoid unwanted and unknowing duplication.

There are no regulations requiring that a person with a Federal research grant must file information with the SIE.

There are two sides to the argument concerning coercive requirements that researchers using public money should make their work public property.

I think that the loopholes that we have as far as the Federal system is concerned is merely a matter of time, if there is any problem here in getting these records. It is a question of time. Getting the records from the thousands of other agencies outside the Government * * * would also be a slow job because there are so many of them, thousands of them.

* * * * * * *

From my point of view as director of the Science Information Exchange, I have a feeling that wholehearted cooperation from the scientist would give us better quality of material.

There has been a great deal more enthusiastic cooperation from many places because of congressional interest and interest from the Office of President in the last few years.

My feeling has been * * * that perhaps the exchange will be a better implement, a better instrument in the long run, if this material can be gotten in, by, shall we say, sweet persuasion, willingness, interest, enthusiasm, and cooperation. It might be slower to build it up, but I think it would be better information in the long run.

(pp. 837–838, 845–849, 852)

Storage and retrieval of information (Ewalt)

The problem of storing, retrieving, and sharing information is a growing problem of national and international dimensions. The work and influence of agencies such as the National Academy of Science should be extended. The Armed Forces National Research Council Committee on Vision is doing an excellent job of coordinating efforts in vision research for the armed services.

(p. 370)

C. Scientific and Technical Publications

Communication of scientific information (Schairer)

[The committee] may find it useful to look into the problems involved in the publication of research results and also the impact of security on the availability of research reports. It is my impression that you will find a healthy attitude by all involved.

Although both aspects present difficulties in communicating scientific information and thus assuring against unnecessary duplication, the difficulties do not prevent research workers from keeping informed on research in their particular fields.

(p. 1036)

Cost of scientific and technical journals (Feldmann)

It is suggested that the Government consider ways to help pay the increasing cost of the scientific and technical journals, through which results of Government research are disseminated. These journals are published at a deficit to their sponsoring societies and associations, resulting in substantial financial hardship.

(pp. 883, 887)

Danger of future unfair competition from tax-exempt journals (Babcock)

There are 600 or 700 society publications at present. They are nonprofit and do not accept advertising. However, if their Government grant or page charge is dropped, they will have to accept advertising. The independent profitmaking publications will then have to compete in the marketplace with publications of nonprofit societies which do not pay taxes. The result is unfair competition between these publications and the independent profitmaking publications.

(p. 928)

Government subsidy of nonprofit publications and freedom of the press (Babcock)

There is competition in the United States for news and information. This competition, which is healthy and in the best interests of a free society, requires free access to news and information. If the Government publishes its own publications, or encourages subsidization of nonprofit publications, there could be a tendency to favor the Government supported publication with better news and information than might be available to a free and independent business press. There is thus raised the question of freedom of the press.

(p. 927)

Publication costs (Ewalt)

The Federal Government is helping in the problem of publication costs by including money in grants for this purpose, and in turn researchers are being charged by the journals for the publication costs. This is a back-door approach, and a more direct method should be used.

(pp. 366, 370)

Results of Government subsidy of nonprofit publications (Babcock)

Government subsidy of nonprofit journals through page charges and grants produces the following results:

First, a page charge is established for publishing editorial material in the publication, and the Government directly or indirectly pays this page charge.

Second, the publication solicits advertising which competes with taxpaying publications which in turn help finance the Government.

Third, since the publishers are tax exempt organizations no income tax is paid on advertising profits which sometimes ensue.

Fourth, the publication is mailed at exempt postage rates considerably lower than those provided for taxpaying publications which are published for profit.

(p. 926)

Suggested studies for the committee concerning Government subsidy of nonprofit publications (Babcock)

Our purpose in appearing today is to fully endorse the excellent concept of this committee. In the same way that you will seek information about research itself, so do we hope that you will include within your study the subject of page charges, grants to publications, alternate methods of dissemination of information, and best utilization of the existing independent press of the United States to the best interest of the scientific and research programs of the United States.

Associated Business Publications * * * has stated that the need for the Government to disseminate the results of Government financed research is certainly recognized by the Association.

We would hope, however, that the committee would look into the matter and determine whether page charges and grants to technical journals are the best method of dissemination. * * * Certainly there are areas where the business press of the United States may work to the definite advantage of the Government. It would be our hope that these hearings would explore this possibility.

(pp. 927–928)

Unnecessary proliferation of journals (Babcock)

The Government, through its subsidy page charge to nonprofit publications, often encourages societies and associations to start magazines to serve their particular area of interest. The area might already be served adequately, or could be, by existing media.

(pp. 927–928)

XIII. CONGRESS AND THE SELECT COMMITTEE

A. Role of Congress
B. Legislative-executive relationships
C. Review of Federal R. & D. programs by congressional committees
D. Role of the select committee
E. Suggestions for consideration by the select committee

A. Role of Congress

Agreement between legislative bodies and the scientific community on importance of R. & D. (Harrar)

Inevitably, legislative bodies and the scientific community have varying approaches to the total problem of Government support of R. & D.

* * * There is common ground in the clear agreement that research and development are essential on a continuous and growing basis for the well-being of the Nation. The legislators must of necessity attempt to keep in balance the multiple needs of our country and decide how to distribute available resources for maximum national benefit. The scientist sees so many areas demanding research that he inclines to press for more support in the conviction that the need is obvious and that past achievements and future prospects justify this position.

(p. 1016)

Congressional policy decisions with respect to R. & D. (Hollomon)

A final point. I believe that you, as members of the Congress, are perfectly capable of making the necessary decisions with regard to policies toward research and development. It is not necessary, nor do I believe desirable, for one to be a specialist in science or engineering to evaluate or to set the national goals for research and development in this country, or even to ask intelligent questions concerning it. Congress does not need to convert itself to a body of nuclear physicists to appreciate the consequences of the development of atomic energy in both peace and war. It does need to keep itself informed on sound technical management principles and on the character and nature of the results of science and insist on effective and capable technical management.

(pp. 294, 299)

Current Government-sponsored research program (Berkner)

Basically, these programs are sound and productive. By far the overwhelming majority are valid and worthwhile.

In conclusion, I should like to pay tribute to the extraordinary prescience of the Congress in mounting the ever-enlarging program of scientific research at the very moment of the technological explosion. No other country has been so timely in its recognition of the nature of changing events. As a consequence, our country has emerged as a world leader.

* * * no government is more conscious of the impact of science on its affairs, and no government has acquired so much experience and proven knowledge in research administration.

Neither Congress nor science need make any apology for the expenditures that have been made. * * *

(pp. 426, 429–430)

Informing the Congress on scientific policy (Calkins)

More efforts such as the conferences sponsored under the Brookings advanced study program are needed to provide a systematic means of informing the Congress of new thinking and discoveries in the physical and social sciences. Far more could be done to provide such opportunities for Members of Congress.

(p. 914)

B. Legislative-Executive Relationships

Effect of adverse congressional reaction on agencies' research (Heald)

It is said that some agencies, for fear of adverse congressional reaction, are avoiding support for projects that they feel are otherwise sound and worthwhile. Certainly courage, inventiveness, and integrity have often been displayed by Government grant-making agencies. It would be a loss to the American people if these characteristics were suppressed. This investigation provides an excellent opportunity to highlight fruitful examples of these characteristics and to reinforce the notion that the public employee may be more responsible to his trust by courage and imagination than by adhering slavishly to what is "safe."

(pp. 388, 402)

Government regulation of R. & D. (Furnas)

There is danger of too tight control over research. Recently there have been criticisms of Federal research grant programs and a few instances of misapplication of funds. Probably there has been some misuse of funds, "due to naiveté rather than cupidity." Some corrections should be made but it is very important that Congress not establish a degree of bureaucratic control which will stifle the national R. & D. program. Bureaucratic controls are inevitable in large organizations, particularly in Government, but in research they must be kept to a minimum and applied with wisdom. The researcher's time must not be wasted, nor must he be unduly frustrated or discouraged—otherwise his efficiency will be reduced.

Congress should use "wisdom and restraint" in legislating regulations for the direction and accountability of Federal research funds, avoiding too much bureaucratic control.

Increased responsibility and authority should be given by the Federal agencies to those at the working level.

(pp. 1008, 1009–1010)

Need for congressional action to improve the organizational structure for overall coordination (Waterman)

[In response to a question whether it was felt that Congress should take some action to improve the organizational structure for overall coordination of research and development, the witness replied:]

I believe that it would help for Congress to get behind the present system and say this is the one that you have told us about, let's make it work.

(p. 824)

Reporting to the Congress by the Executive (Staats)

There needs to be improvement in the means for communicating to the Congress, on a systematic basis, on research and development programs of the various agencies. This indicates the need for more adequate reporting by the executive branch.

The executive branch should keep Congress more fully advised by:

(1) Following through on the President's budget message with information developed by the Bureau of the Budget and the Office of Science and Technology which would describe and evaluate trends and changes in R. & D., indicate emergency R. & D. investment opportunities, comment on the balance among fields of supported research, and furnish measures of the impact of the R. & D. program on our supply of manpower, our industries, and the universities.

(2) Developing more adequate reports of agency research programs for the information of Congress, explaining the projects and progress made.

(3) Developing special crosscutting studies and reports on problems common to all Government agencies in administering R. & D.

(pp. 567–568)

C. Review of Federal R. & D. Programs by Congressional Committees

Congressional organization as it relates to Federal research programs (Kistiakowsky)

Under the present congressional committee setup, with different committees reviewing different Federal agency programs, a particular congressional committee sees the Government's R. & D. program only in part, the program of a single executive agency.

It is recommended that the Senate and House each have one committee to furnish an overall evaluation of Federal R. & D. to strengthen congressional role in science. Such a committee need not have legislative authority that would conflict with the authority of the Appropriations Committees or the authorizing committees.

Its role might be the evaluation on their merits of the various research programs regardless of the agencies concerned and the transmission of its findings to the relevant congressional committees having authorization and appropriation authority. This activity will greatly strengthen the role of Congress in the scientific field. * * *

(p. 612)

Congressional review of R. & D. problems or programs from a total perspective (Wiesner)

* * * All too often, the Congress is obliged to consider these subjects from the point of view of one program or one agency, when many of the most important current issues in research and development cut across the entire range of Federal interests. * * * it is vital that the Congress, or at least some groups within it, be able to examine the scope of Federal programs and of the problems and opportunities that face the Nation in science and technology.

The committees in Congress who have the responsibility for these agencies [dealing with oceanography] haven't the same determination to hold a national program together that the Space Committee has, for example, to be sure there is an integrated space program.

(pp. 256, 276)

Congressional supervision of national R. & D. (Furnas)

Standing congressional committees with capable staffs for review of R. & D. programs are desirable and in order, though there is danger of a proliferation of such special committees which will tend to overlap and get in each other's way.

Consideration might be given to the establishment of a standing joint committee with oversight of the entire national science program.

(p. 1010)

Need for a congressional committee to review all Federal R. & D. (Killian)

Congress should evolve an organization to give comprehensive attention to Federal science and technology as a whole, both as to money and personnel, in order to evolve sound policy. There should be at least one group in Congress viewing the whole program in order to be informed about "little science" and "big science," and to develop a frame of values and a sense of proportion, and to establish national priorities.

Congress particularly needs a group to be informed on the less glamorous, less spectacular, but less obvious and fundamental work in science. "Big science" is important too, but it must be related to the greater whole.

The executive branch has been evolving an organization to do this, but it is vital for Congress to do so.

Through appropriate committees or in other ways, Congress might have a focal point of information and policy initiation similar to the Parliamentary and Scientific Committee in Great Britain.

(p. 752)

Organization for scientific choice (Weinberg)

The legislative branch lags behind the executive branch in the institutional organizations for making scientific choice. Establishment of the Science Adviser, the Federal Council for Science and Technology and the Office of Science and Technology are regarded as major steps forward by the executive branch.

Congress has no organization through which it can look at its expenditures for basic science as a whole and thus make informed choices among competing fields and projects. Both basic and applied science are viewed by many different committees; each committee, like each Government agency, looks at its activities from a rather parochial viewpoint.

I do not have any highly original or obviously valid suggestions as to how Congress can look at its expenditures for basic science as a whole, and thus weigh one field of basic science against another; or how it can weigh one technological project * * * against another * * *. Perhaps the select committee itself together with a permanent, scientifically competent staff, can become a permanent body, possibly as a subcommittee of the House Appropriations Committee. Various competing claims for the scientific dollar put forth separately by the different committees could then be balanced against each other, by a knowledgeable arm of the Appropriations Committee, in much the same way that conflicting claims in the executive branch are reviewed by the Office of Science and Technology.

Congress needs a pool of talent similar to the President's Science Advisory Committee to assist it. The National Academy of Sciences could supply this talent.

(pp. 316–317, 329–330)

Technical advisers to the Congress (Bachman)

The difficult task of the Congress in evaluating technical programs of the different Government agencies, "will get worse, not better, unless some way is found to cope with it." The NAM Research Committee "concludes that Congress * * * finds itself at a disadvantage with the Executive agencies in the matter of evaluation. * * *"

It appears that the executive departments and agencies have access to scientists and scientific advisers which the legislative branch apparently does not have. Congressional committees, it would appear, must choose between the alternatives of accepting the proposals of the agencies or arbitrarily withholding authorization and appropriation. The traditional system of checks and balances threatened with disappearance is absent in this process.

* * * we think that Congress might well wish to take advantage of the potential availabilities of * * * highly trained and competent directors of industrial research. Undoubtedly, their industrial experience has sharpened their appraisal ability. In general, use of such men would give Congress evaluations quite independent of an academic approach.

It is the wish of the NAM Research Committee to offer assistance to Congress by submitting to its committees or members thereof, on request, names of a number of men, regardless of academic or industrial connection, selected on the basis of their technological background and demonstrated competence in the evaluation of research in the area of request. Generally speaking, two or three times the number of names required for the assignment would be submitted. Such persons could review, study, and offer advice on scientific or technological projects for which Government funds are requested. Further, if your select committee feels that such persons could be helpful in your present studies, we stand ready to furnish names: we think they can be helpful.

The NAM wishes to play no part in the ultimate selection of evaluators and so invitations to the individual men would come directly from the Congressmen or congressional committee. Service * * * would be ad hoc in nature * * * which would tend to keep costs at a minimum.

(pp. 778–779)

D. Role of the Select Committee

The committee's assessment of the entire Government research effort (Denney)

The committee's aims should be much broader than merely identification of mismanagement in specific research programs. Far more important is the unique opportunity to make an assessment of the entire Government research effort.

In addition to areas of duplication, the committee may wish to identify some areas of neglect. For example, Chinese studies have not been given the attention that have Russian studies. There is a question whether the balance between research in the social sciences (2 percent of total Government research) and research in the physical and life sciences is correct. The committee may wish to explore the total "mix" of Government research.

We in each executive department can only see that part of the whole research picture which relates to our own activities; you can obtain an overview which can lead to more efficient use of the Nation's resources for research.

(pp. 192–193, 196–197)

Congressional responsibility and competence in science policy (Teller)

Detailed knowledge from technical people is obviously needed, but there cannot be scientific agreement on the scientific future.

* * * I hope that these decisions will not be delegated to scientific committees that, as committees often do, often are induced to do, come up with unanimous recommendations.

Differences of opinion about these vital future developments are essential. To my mind the only sound way to proceed is your way, having the broad knowledge and the heavy responsibility concerning many things of which science is only one. I hope you will listen to the great variety of different opinions, and then reach your own conclusions.

(pp. 938, 950)

Congressional scrutiny of research programs (Brown)

Finally, I believe that our research programs should continue to receive the close scrutiny that has been exercised by the committees of the Congress for Appropriations, Armed Services, Science and Astronautics, Atomic Energy and Government Operations; and I believe that the establishment of this select committee by the House can provide additional benefits to the total Government research program.

I think that the details in research may be too many for any single body either in the executive or the legislative branches to turn their attention to, and I think that policies of geographical distribution, in-house, industrial, special corporation decisions involve some very important matters of policy; the relations between the Government and the universities involve some important matters of policy. I think that many of these areas require an across-the-board look by a representative congressional group, and I think that this committee is ideally suited for such a purpose.

(pp. 174, 179)

Executive-legislative cooperation in science and technology (Waterman)

Finally, and in particular, the establishment by the President and the Congress in the executive branch of the statutory Office of Science and Technology leads to the hope and the expectation that there will be greater opportunity for cooperation between the executive and the legislative branches of the Government in the solution of the increasingly complex and important issues that lie before the country. Toward this end I believe that the establishment of this select committee in the House is most significant.

(pp. 815, 822)

Maintenance of fundamental integrity of science during committee's investigation (Weinberg)

* * * I believe the investigation which you are undertaking is most worthwhile and that it can be the beginning of an ever more enlightened relation between science and Government than our country has already enjoyed. On the other hand, I can foresee a possibility that such an investigation might put into motion forces which could hurt much that is of inestimable value to our society. When $15 billion is spent, inevitably examples of waste, possibly even dishonesty, can be found. But I believe that the remarks of Mr. Elliott on the floor of the House sum up the essence of the situation: "The history of all mankind proves that knowledge is power—and when scientific research lags, knowledge stagnates and civilizations crumble." The scientific edifice our Nation has built is one of its

finest achievements. It is profoundly important that we maintain its fundamental integrity, even as we do what we can to improve its architectural details.

(p. 320)

Means by which the committee's work may be accomplished (Heald)

(1) Solicitation of information and opinions from all interested parties, including science journalists, scientists who have not been closely associated with Federal research, and a few scholars from the humanities and social sciences.

(2) Use of two studies under preparation by committees of the National Academy of Sciences, and by the Rand Corp.

(3) A "clear and realistic understanding of the broad categories of activities going on under the rubric 'research,'" leading to a distinction between them based on their different needs and characteristics, in order to prevent overgeneralization about such a wide spectrum of activities.

(p. 382)

Means of informing Congress of our national scientific needs (Berkner)

Science through its societies and its National Academy of Sciences bears a responsibility through timely studies and reports. The administration, through all of its mechanisms, owes the Congress clear analyses of the situations for which support is solicited.

But basically, I see no ultimate alternative but the method of congressional inquiry which you are using here. Such inquiry forces each element of the scientific community to search deeply for the answers that are of vital concern to our Nation. It serves to develop the diverse views of protagonists in which all areas of scientific thought can participate. Open inquiry provides the views of all to the Congress and to the people from which a wise judgment can be derived.

(pp. 438–439)

Possible duplication of functions of the select committee and of the Office of Science and Technology (Wenk)

* * * I believe there is a requirement from our point of view to look at the matter of duplication, but in no way does this preempt the responsibility, as we understand it, of the Congress. In other words, from the point of view of separation of powers, I would visualize our roles as being quite parallel, but in no way would we be duplicating each other in this regard, but our objectives certainly would be the same. * * *

(p. 253)

The proper role of R. & D. in the long-range needs of our country (Seaborg)

The thoughtful study of the select committee can do much toward the delineation of this problem.

(p. 65)

Strengthening ability of Congress to assess research programs (Denney)

The committee can be of service in strengthening the ability of the Congress to assess Government research programs. Policies and principles are needed to guide the wise use of the research dollar.

Any help in formulating guidelines will contribute to the national interest.

(pp. 193, 197)

E. Suggestions for Consideration by the Select Committee

Areas of Federal R. & D. which need examination (Jones of Esso)

(*a*) *Space exploration*

This area should receive careful study by Congress since it is so predominately a Federal Government responsibility.

I am sure the Congress is giving serious attention to whether alternate uses of some of these funds and the scientists involved might produce greater benefits to the country as a whole.

(*b*) *Research oriented toward consumer markets*

At present this is not a large area of Federal Government research expenditures (other than in nuclear power and the food industry), but it appears to be growing, and with the too prevalent climate of opinion that if a little research is good, a lot more is a lot better, we are concerned that Federal research oriented towards the consumer market will grow rapidly, displacing or duplicating privately financed research, with resultant loss to the overall economy. [Advantages of having private enterprise conduct this type of research are enumerated.]

[In questioning concerning specific Government research and development programs which might more appropriately be turned over to private industry, the following examples were mentioned: (*a*) development work on formulation of insecticides and herbicides; (*b*) the fertilizer business; and (*c*) utilization of natural oils in protective coatings. Additional examples mentioned later in questioning were the use of atomic energy for power, making liquid hydrogen carbons out of coal, and shale oil recovery.]

It is areas like these that I refer to. They are not large, * * * but we are concerned lest they become large. All of us in industry * * * have been brought up in an atmosphere of severe competition, and we know how to operate in this atmosphere, and we welcome it, but not from the Government. This is the competition that private enterprise cannot possibly win.

* * * What I am recommending is to have a long-range goal of getting the elements of the civilian economy in the hands of free enterprise.

(pp. 783–784, 784–785, 786)

The effects of the Federal Government's R. & D. programs (Thomas)

Federal expenditures have increased from $74 million in 1940 to $12 billion in 1963—a change which has profoundly affected the character and motivation of research being done in this country.

* * * But the effects on other parts of the economy and, in fact, on the basic social attitudes of the average citizen are perhaps even more profound. I will venture an opinion that even political attitudes may be modified. * * *

There are today about 400,000 scientists and engineers in the country, engaged in R. & D. work.

* * * It is my opinion—one that I earnestly hold—that this inventory represents the country's greatest resource.

How this resource is used, developed, and maintained, its morale, its economic security are all of concern to this committee. The inventory is created primarily by the research work itself, and is added

to by education and depleted by death and economic attrition. The motivations of the individuals are strongly influenced not only by scientific curiosity but by the redistribution of the funds in the Federal research budget. Only slowly will total numbers of personnel be changed.

I would like to restate this, because in my opinion it is the most significant way to view the main problem of the committee, which is to insure that research and development funds are wisely spent in the public interest. The manipulation of the inventory of the research talent of the country and its allocation to specific purposes is the result of a system of buying and selling research that has some of the characteristics of a free market. In this market the Federal Government is the largest single buyer and its influence is overwhelming. The work of this committee would be most effective if it can recommend practices in the various contracting agencies of the Government that will insure that all aspects of this exchange be considered, including the recognition that research itself adds to the inventory of scientific talent.

This is, I believe, the broadest statement of the problem. * * *

(pp. 410–411)

Effect of Federal research programs on scientific and technical manpower (Peyton)

A very difficult and complex problem which the Chamber believes the subcommittee should consider is the impact of Federal research programs, conducted within Government and by contract or grant, on the technical and scientific resources of the Nation, particularly manpower. * * *

(p. 1034)

Evaluation of classified research (Bush)

* * * I have great sympathy for this committee in their task of judging our program in the open research field. I suspect that sound judgment on military research is just as badly needed, and almost impossible to arrive at without far more effort than I believe is now contemplated.

(p. 463)

Protection of universities engaged in Government-supported R. & D. (Killian)

Higher education is strongly affected by Government research policy and is responsive to changes in that policy.

Congress should concern itself with seeing that the Government protects universities through providing for long-term research grants, through providing for full reimbursement of indirect costs, and through grant and contract procedures that recognize the difference between the funding of basic research and materiel procurement.

(p. 754)

The purposes in an investigation of R. & D. activities (Waterman)

* * * we should not make the mistake of assuming that major economies can be brought about by an investigation of science and the activities of scientists, unless indeed one wants to jeopardize our future technology.

What does require special attention is the review and analysis of what we are spending large amounts of money for, whether national goals are truly served by these programs, whether the programs presently planned will indeed attain their objectives, and whether these operations are conducted efficiently and economically.

(pp. 809, 811, 815, 819)

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Relation of scientific research to the economy (Berkner)

The committee should examine the role of scientific research in the light of our national situation and establish clearly the relation of science to the rise of the new economy of plenty. It should endeavor to find the most suitable levels of scientific research, and of graduate education required to optimize that research, in order to stimulate the economy at the necessary pace. There is evidence that moneys spent for research are rapidly multiplied in our new economy, in industry, employment, wealth, and tax returns.

Innovation from the scientific understanding and control of nature is an important new resource for the country, and now provides for about half of our economic activity. It is a characteristic of this resource that it continually releases manpower through the steady rise of productivity of the highly educated and creative individual. We are now fully committed to reliance on this new resource for future national growth. Innovation from scientific understanding of nature has four elements:

1. Scientific research, to uncover the functional behavior of nature, the general laws that govern that behavior, and the technologies that can command that behavior under man's control and for his benefit.
2. Education, very advanced and continuing—at the graduate level and beyond—competent to advance knowledge in all areas through scientific research, and to infer from new knowledge those innovations that are useful to mankind. Likewise, education at all intermediate levels is imperative. * * *
3. Energy, derived out of and controlled by the technologies as they emerge. Today, controlled energy replaces "labor."
4. Capital, which can direct the major energies of society toward the creation of the mechanized means of production whereby productivity is vastly enhanced and the power of the new resource fully developed and released.

(pp. 422, 428–429)

Review of Federal agencies conducting R. & D. (Furnas)

The functions and programs of the forty Federal agencies involved in R. & D. should be evaluated thoroughly to see if "consolidation, elimination, or transfer of authority" are advisable.

(p. 1010)

Suggested areas of investigation for the select committee (Peyton)

In addition to the areas of investigation now contemplated, the chamber suggests that particular attention be given to the following problems for which solutions must be found if the proper objectives of Federal research are to be achieved within the limits of the Nation's scientific, technical, and financial resources:

(1) Better identification and definition of Federal research expenditures.
(2) A means of achieving better management for and increased productivity in Federal research programs.
(3) More effective coordination and review of Federal research programs.
(4) Realistic assessment of the impact of Federal research programs on utilization of scientific and technical manpower, and on the Nation's institutions of higher education.
(5) Increased incentives for industrial research.

[Each was discussed separately and will appear under the appropriate heading.]

(p. 1032)

Suggestions for committee studies (Staats)

Suggested problems for committee study:

1. Standards and procedures for selection of research projects and for the review of on-going projects.
2. The importance of strong support for basic research and its long-range investment value in competition with immediate needs of applied research and development.
3. International joint research efforts and the increasing opportunities for international cost-sharing in scientific research.
4. Administrative problems of universities resulting from Federal support, especially as regards the hardship caused by indirect cost allowance.

(pp. 568–569)

Suggestions for types of research for the committee to study (Heald)

Most of the committee's inquiry must necessarily be devoted to the largest Government research programs—defense-related, health, and atomic energy, for example.

The committee might also concern itself with research connected with urban transportation, manpower training, and foreign policy. It might also consider whether Government agencies might be given modest research funds to do research about the effectiveness of their own work.

(p. 384)

ALPHABETICAL LIST OF WITNESSES APPEARING BEFORE (OR FILING STATEMENTS WITH) HOUSE SELECT COMMITTEE ON GOVERNMENT RESEARCH

Dr. O. C. Aderhold, president, University of Georgia.
Mr. John B. Babcock, senior vice president, Associated Business Publications.
Dr. Paul W. Bachman, chairman, Committee on Research, National Association of Manufacturers.
Dr. W. S. Bailey, associate dean of the graduate school and coordinator of research, Auburn University.
Dr. William R. Baldwin, dean, College of Optometry, Pacific University.
Dr. Lloyd V. Berkner, president, Graduate Research Center of the Southwest.
Dr. Robert C. Berson, Association of American Medical Colleges.
Mr. Andrew J. Biemiller, legislative director, AFL–CIO.
Dr. F. J. L. Blasingame, executive vice president, American Medical Association.
Dr. Harold Brown, Director of Defense Research and Engineering, Department of Defense.
Dr. Vannevar Bush, Massachusetts Institute of Technology.
Dr. John C. Calhoun, Jr., Assistant and Science Adviser to the Secretary of the Interior.
Dr. Robert D. Calkins, president, the Brookings Institution.
Mr. F. R. Collbohm, president, the Rand Corp.
Mr. George C. Denney, Jr., Deputy Director, Bureau of Intelligence and Research, Department of State.
Dr. John S. Dickey, president, Dartmouth College.
Dr. Lee A. DuBridge, president, California Institute of Technology.
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Mr. Boisfeuillet Jones, Special Assistant to the Secretary of the Department of Health, Education, and Welfare (for Health and Medical Affairs).
Dr. Charles F. Jones, president, Esso Research & Engineering Co.
Representative Robert E. Jones, Jr., chairman, Subcommittee on National Re sources and Power, House Committee on Government Operations.
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Dr. Alan T. Waterman, president, American Association for the Advancement of Science.
Hon. James E. Webb, Administrator, National Aeronautics and Space Administration.
Dr. Alvin M. Weinberg, Director, Oak Ridge National Laboratory.
Dr. Edward Wenk, Jr., Executive Secretary, Federal Council for Science and Technology, Executive Office of the President.
Dr. Jerome B. Wiesner, Director, Office of Science and Technology, Executive Office of the President.
Dr. Logan Wilson, president, American Council on Education.
Hon. W. Willard Wirtz, Secretary of Labor.

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